PHYSIOLOGY FOR BEGINNERS

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FOR BEGINNERS

BY

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AUTHOR OF "ELEMENTS OF PHYSIOLOGY," ETC.

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TO THE TEACHER

This book is taken up chiefly with inculcating practical truths concerning the health, most of the difficulties of the important science of physiology being deferred for later study.

Correct and practical ideas about health cannot be safely deferred, however; for it is probable that the mistakes made in the physical life of fast-developing children form one of the chief causes of failure of health in adult life. The cigarette habit alone warns us that boys should be taught at an early age reverence for their bodies. That girls should grow up with better ideas of taking care of themselves than they usually have, is shown by the widespread ill health existing among women. Dr. Cyrus Edson stated in the *North American Review* that he and a friend wrote out a list of four hundred and twenty ladies of their acquaintance in New York City, and that only twenty-seven of them possessed what could be called sound health. Lack of exercise and the wearing of deforming clothing are probably the chief causes of this deplorable state of affairs; the only hope of remedying

the evil is to instill correct ideas into the minds of girls of ten or twelve years of age before injurious habits of life are formed and before the rapid development of the adolescent period begins.

Want of respect for the body is even more prevalent among boys than among girls. In some communities half of the boys smoke cigarettes and weaken themselves for life. Teachers often find it best to supplement the instruction with a private talk with a boy who has begun this suicidal habit; not only for his own good, but because, owing to the popular indifference and recklessness about health, the habit may spread from one boy to a whole private or public school. Prevention is a hundred times better and easier than cure. A private talk often convinces the boy of the teacher's personal and unselfish interest in his welfare and prepares his mind to receive the instruction in class.

The purpose in writing this book has been to bring the study of physiology near to the life of the community and especially to the life of the child; for no other study presents so good an opportunity to connect school and society. Nevertheless, it is hoped that every statement, even when made apparently in the most informal manner, will be found to have been as carefully weighed as if written for older minds. No attempt has been made to avoid

the warmth and friendliness of style that is natural in addressing the pupils for whom this book has been written; neither has there been an attempt to use childish language, although the language is simple.

The book contains innovations in method which it is unnecessary to discuss with professional teachers. The changes had their origin in those fundamental principles of pedagogy which are universally accepted; as to the skill with which they have been carried out, it remains for the teacher and for use in the school to decide. The language used is as simple as that of fourth readers. While intended for recitation in the two grades next higher, it is believed that the book is likewise well adapted for use in the fourth school year as supplementary reading, accompanied by the oral instruction of the teacher. Thus it may supply work in three years of the graded school course.

The "Health Primer" of this series is intended for use in the third and fourth grades.

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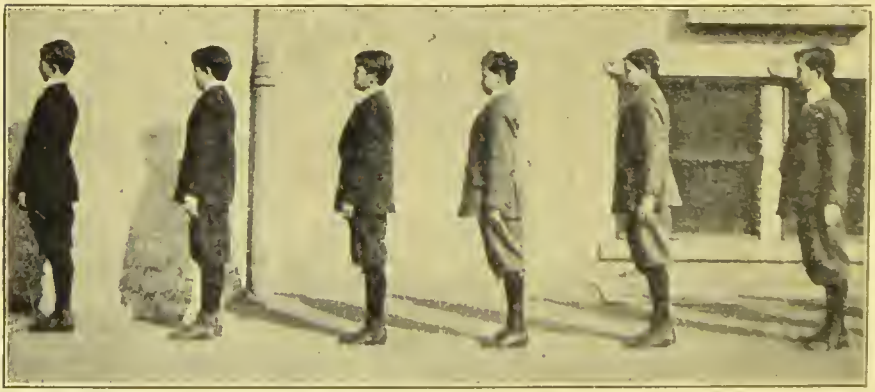
How Girls Carry Books: Forward on the hip. This may twist the spine and make shoulder too high on that side. Boys carry books under one arm with shoulder on that side too low. Compare heights of your shoulders after method of fig. 13, p. 23.

Correction of Posture by dividing the load. Another way is to change to other arm at end of each block, or on every other day. (From Bancroft's "The Posture of School Children," a useful book for teachers.)

GIRLS UPWARD STRETCHING, to straighten themselves, but not knowing how.

UPWARD STRETCHING, to improve posture, after the teacher has shown the right way.



A GROUP OF WELL-POISED BOYS. Their houses will not have crooked frames. Bodies kept straight until 16 years old remain straight. Bodies that become crooked in youth usually stay crooked.

PHYSIOLOGY FOR BEGINNERS

CHAPTER I

THE SKELETON

A Beautiful House. — A man who wrote a book about the body called it "The House I Live In"; another writer has called it "The House Beautiful." In these books the body was compared to a house, and parts of it were named from the parts of a house, as the framework, the pantry, the door, the hall, and the windows. Can you tell your teacher what was meant by the door, the hall, and the other parts mentioned? But who ever heard of a house that was alive and walked!

A Curious Custom. — In England sometimes poor people who are able to build only very small houses, go from village to village to work or to peddle, by placing their houses on wheels, and moving them with horses. Thus they travel around the country, eating and sleeping in their houses. Sometimes they have a little shop in one end of the house, where the man cobbles shoes or sells and mends tinware or gives Punch and Judy shows. Such a house is called a van.

Van is a short word, but you may never have

heard it because we have no such vans in America. The roads here are usually not so smooth and well paved as in England, and the towns are not so close together.

FIG. 1. — The Backbone, or Spinal Column.
Can you count the bones in it? Do you see the places for the pads of gristle?

Would you like to see a van moving along with the smoke going out through a little stove-pipe?

Jolts and Jars. — Vans must have good strong frames, for they are more likely to fall to pieces than the house which remains in one place. So this wonderful house in which we live must be built well, for it moves quickly from place to place. It has a strong and perfect framework called the skeleton.

The backbone, or spine, is the main pillar or column that supports the building. Although called a bone, the backbone is not one bone, but a number of bones put one on top of the other, forming a tall pile. Between the bones are little pads of gristle, which are elastic, though not so elastic as rubber. They help to lessen the force of any shock or jar, just as the springs of a carriage lessen the jolting.

The master of the house lives in a room called **the skull**, situated on top of the main pillar. It is not square, like most rooms, but round. If there were sharp corners, the walls would be more likely to be injured. The walls are firm and stout. The two windows through which the master looks are placed in front and high up in the wall, so that he can see a great distance. That these delicate windows may not be easily injured, the bones forming the brow, the nose, and the cheek stand forward around them. The nose, which tests the odors of things that come into this beautiful dwelling, is conveniently placed just above the mouth, or doorway. Before you study much about this house, perhaps you will conclude that it is not only the most beautiful and convenient, but also the most wonderful house to be found in the whole world.

There are only two more rooms in the house, and they are in the large part called **the trunk**. The two rooms, or cavities, are called the chest and the abdomen (ab-dō′men). The chest contains a perfect pump called the heart, and a pair of large bellows, called the lungs, for bringing in fresh air and sending out impure air. The lungs and the heart are very delicate. They are protected by twenty-four flat ribs, which curve from the spine around the chest somewhat like the hoops of a barrel, and unite in front with the breast bone. The abdomen is just below the chest, and is separated from it by a fleshy partition. It contains the stomach, liver, intestines, and several other important organs. The organs are

supported from beneath by two large bones called hip bones. These bones form a kind of basin (Fig. 5), the edge of which can be felt at the hips.

The shoulder and arm are as well arranged as the rest of the body. In order that the arm may be held out from the trunk and have greater freedom of motion, it is not joined directly to the trunk, but to the shoulder. The shoulder blade is a broad, three-sided bone. At one end is a shallow cavity, into which the round head of the arm bone fits. The shoulder blade would not stand out alone from the trunk, so the collar bone acts as a brace to hold it in position. You can feel the collar bones above the chest like slender crossbeams running from the breast bone to the shoulder blades. Move the shoulder up and down. Does the collar bone move up and down? Put your right hand on your left shoulder. Does the shoulder blade move? The collar bone is sometimes broken by falling heavily on the shoulder. Boys who are reckless climbers have broken it in this way by falling from trees. After the collar bone is broken the shoulder falls forward, as there is nothing to keep it in position. A broken bone in a boy heals in about six weeks.

A joint is a place where two bones are joined together. There are several kinds of joints in the body, each allowing a different kind of motion. The shoulder joint is called a ball and socket joint because the round end of the arm bone fits into a socket on the shoulder blade. At the shoulder joint you can move the arm up and down, backward

and forward, and in all directions. A ball and socket joint allows motion in all directions. (Fig. 6.)

The arm is divided into the upper arm, forearm, and hand. The upper arm has only one bone. (See Fig. 2.) The forearm has two bones. One of them turns around the other, thus allowing the hand to be turned over; this is a great convenience in using the hand. (Try turning the hand; will it go all the way around, or only half around?) To the forearm is joined the wrist, which is made up of eight little bones, shaped somewhat like blocks and fitted together like the bricks in the pavement. Since they glide over one another as the wrist bends, these joints are called gliding joints. See how smooth and curved the wrist is when it is bent. This is because there are several joints instead of one. (Fig. 7.)

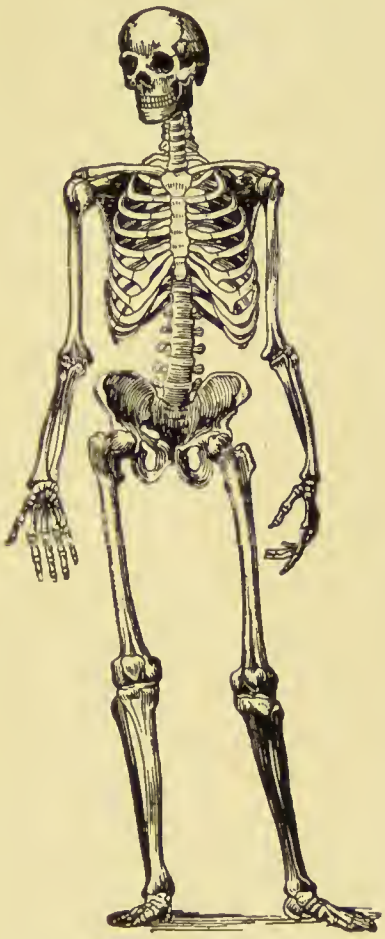


FIG. 2.—The Skeleton.

You see by the picture that the fingers appear to extend to the wrist. This is because the palm is made up of five bones shaped like those of the fingers. In the skeleton hand the difference between

the fingers and the palm is not noticeable. Which could you better afford to lose by accident, a thumb or a finger? A thumb or two fingers? Could you do more with the thumb and forefinger than you could do with all of the fingers without the thumb? Why is the thumb so much more useful than any one of the fingers? What kind of people talk with their fingers? Did you ever hear of any one who could read with his fingers?

The legs have the same number of bones as the arms. There is no bone in the arm corresponding to the knee cap at the knee. There is, however, one bone less in the ankle than in the wrist, so the numbers are equal. The upper bone of the leg is called the thigh bone. It is the largest and strongest bone in the body. It is so large and heavy that the warriors of savage tribes sometimes carry as weapons the thigh bones of slain enemies. The thigh bone joins the two bones of the lower leg at the knee. (See Fig. 2.) The knee cap is a flat, round bone that protects the knee joint from injury. If you straighten your leg and rest the foot upon the floor, you can move the knee cap with your hand. Can you move it from side to side or up and down?

The two bones of the lower leg are the shin bone and the splint bone. The splint bone is very slender. The surface of the shin bone can be felt just under the skin. Can you feel it all the way from the knee to the ankle?

The seven **ankle** bones are not so regular as those

in the wrist, and one of them, the heel bone, is nearly as large as the other six together. The bones of the ball of the foot correspond to those of the palm, and the bones of the toes to those of the fingers. Which toe has only two joints? The bones of the foot taken together form an arch, so that the middle of the foot hardly rests upon the ground. Upon this firm but springy arch the weight of the whole body is thrown at every step, without shaking or jarring the other bones or the delicate organs. (Fig. 9.)

FIG. 3. — A Vertebra.
One of the bones of the spinal column.

The Joints. — The pieces in the framework of the van, or the little house on wheels, are fastened firmly together, so that not one piece of the framework can get out of place. Most of the parts in our skeletons, or framework, are joined together in such a way as to allow motion. Can you state what a joint is? We have over two hundred bones in our frame. All the joints are movable except those in the hips and the skull.

FIG. 4. — The Skull.

The Joints of the Skull. — The round bony case called the skull, which holds the delicate brain and protects it from injury, is made of eight bones beautifully fitted together. Look at the picture (Fig. 10), and you will see how the bones are put

together at the top of the head and how their edges are notched. They fit into one another like the notches at the corners of a chalk box, but the notches in the bones are not all of the same size and shape. The skeleton has immovable joints where delicate organs are to be protected, and movable joints where motion is necessary. Which bone of the head is fastened by a movable joint? Why are most of its joints immovable?

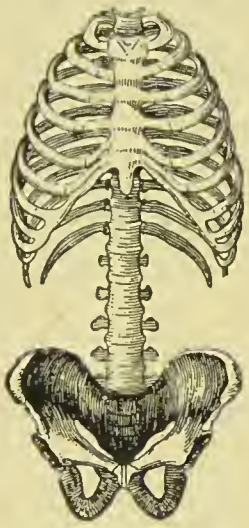


FIG. 5. — The Bones of the Trunk.

The upper room has ribs of bone in its walls. The lower room has walls of muscle.

Try to pick up a pencil from the desk without bending a joint of the hands. You see how helpless you would be were the joints immovable. Joints that allow movement back and forth like a door are called **hinged joints.** Can you tell why they are called hinged joints? A straight rounded ridge on the end of one bone fits into a groove in the end of the other. The elbow joint does not allow so free movement to the forearm as the shoulder joint allows to the whole arm. Describe the motion of the elbow joint. What joint in the leg is like it?

FIG. 6. — The Two Bones of the Shoulder, and the Ball on the Bone of the Arm fitting into a Hollow in the Shoulder Blade.

The leg can swing outward at the hip as well as backward and forward. You learned when study-

ing the arm that a joint which, like the shoulder and hip, allows motion in all directions, is called a **ball and socket joint.** (See Fig. 6.) It allows motion in all directions because one bone has a round ball-like end which fits into a cuplike cavity, called a socket, in the other bone. Which joint allows freer motion, the shoulder joint or the hip joint? Why are you glad that it is so? The bones at the hip are separated, or dislocated as it is called, less easily than the shoulder joint; this is because the socket is deeper.

FIG. 7.

How many bones are in each finger? In the skeleton of the hand, why does each finger appear to have an extra joint?

Some joints allow motion somewhat like a wheel turning on an axle or a top turning on its point. Such joints are called **pivot joints.** The forearm allows the hand to turn in this way. This is because one of the bones of the forearm turns over the other, its upper end being fastened at the elbow, the bone turning like a wheel on a pivot. There is only one more pivot joint in the frame besides those in the forearms. Can you find it?

FIG. 8.—The Hand of a Monkey, holding to a Limb.

How does it differ from a man's hand?

You learned when studying the bones of the wrist that they glide over one another and form what are called **gliding joints.**

Can you now name the four kinds of movable joints and give an example of each? What kind of joint is found in the fingers? Name the four ball and socket joints. What kind of joints do you think is most numerous in the body?

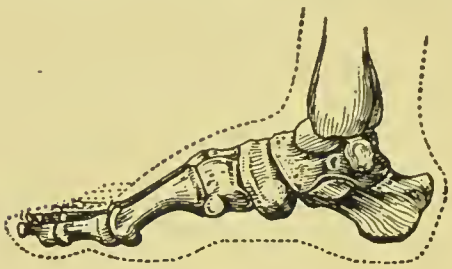


FIG. 9.—Bones of the Foot.

The joints of the spine are hard to classify. One bone does not move over another, as in the movable joints, yet as they allow a little motion, these joints cannot be called immovable. This motion is possible because the pads of gristle, or cartilage, between the bones can be squeezed together a little at one side and stretched a little at the other. If sitting or standing, you bend too far forward, the cartilages become V-shaped and the spine is rounded backward. If you write at too high a desk or always carry school-books and other things in the same hand, the spine may, in time, become bent to one side. Such joints are sometimes called **mixed joints.**

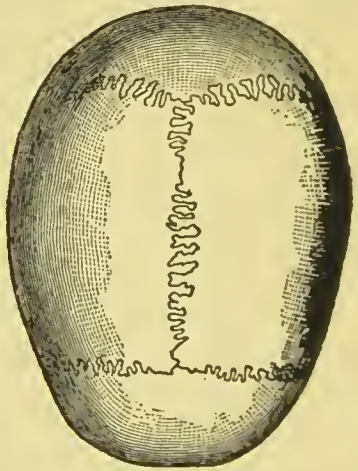


FIG. 10.—Top View of the Skull, showing Immovable Joints.

You did not know that you are taller in the morning than you are at night. The weight of the body during the day compresses the pads of cartilage in

the spine; but when you lie down during the night they regain their usual size. Early in the morning let some one tack a strip of wood to a post so that the strip just touches the top of your head. Stand under it again in the evening. Does your head still touch it?

The ribs that join the breast bone are fastened by one cartilage, just as the bones of the spine are fastened to one another. (See Fig. 5.)

The immovable joints (where are they found?) have *no* cartilages in them. The mixed joints have *one* cartilage each. The movable joints have *two* cartilages, one on each bone, so that the surfaces of the bone do not rub together, but the smooth, white cartilages rub together instead. If the hard bones in the movable joints touched one another, a sudden jar might break them. The layer of tough gristle or cartilage over the ends of the bones prevents this. Cartilage is not brittle like bones. Would you like to feel cartilage? Then you may feel your ear. It is all cartilage except the skin which covers it and the fat that is in the little lobe at the bottom. Is cartilage tough? Does it bend. Is it elastic? Is it hard or soft? Did you ever see the shiny white cartilage on the end of a fresh bone as the bone of a fowl? Dry bones have lost their cartilage.

Something besides cartilage is necessary for a joint. Suppose you put two bones together that belong together. See how readily they fall apart. To keep the bones together, the joints are provided

with stout bands or cords called **ligaments**, which fasten the bones together. They are very strong.

Children sometimes make the joints of the fingers crack. This should not be done, as the joints are weakened by stretching the ligaments. The bones of the joints move noiselessly. This is because there is in the joint a slimy liquid, like the white of an egg. Did you ever see this liquid when the joint of a fowl or a soup bone was being disjointed in the kitchen? One of the bands or ligaments is like a collar, and keeps this slimy fluid in the joint. The more you use the joint, the faster the liquid is formed, so there is always just as much as is needed. Did you ever hear of machinery that oiled itself? Suppose some one should make you a present of a beautiful sewing machine or a bicycle. Would you not take great care of it? We should take even greater care of the perfect body given us, so that it may remain perfect in form and grow strong and healthy.

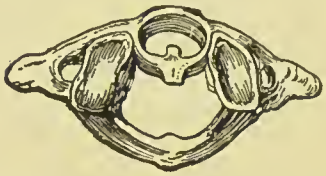


FIG. 11. — The Topmost Vertebra showing the Two Sockets in which the Skull rests, and the Hole for the Peg of the Second Vertebra.

FIG. 12. — Second Vertebra showing the Peg for the Pivot Joint with the First Vertebra.

Are you becoming "round-shouldered" or flat-chested? If it takes you two years to become round-shouldered because of carelessness in sitting and standing, how long will it require with care for you to regain a correct shape? If you put

poisons, like alcohol and tobacco, into the body, they may prevent the bones from growing to full size and becoming sound and strong. Do you know of any boys who have smoked cigarettes for several years? Are they as strong and large for their ages as other boys? Are they rosy-cheeked and healthy? Did you ever know a father who advised his son to use tobacco, even though he used it himself? Fresh air and sunlight, work and play, are good for the bones.

FIG. 13. — This boy was told by his teacher that he was nearly a half inch lower at night than in the morning. He could hardly believe it, and he is tacking a strip so that it just touches the top of his sister's head. He may be surprised when she stands under it again at night.

The rule for sitting: **Sit as far back in the seat as you can. Never allow yourself to slide forward in the chair.**

The rule for standing: **Head up, chin in, chest forward, hips back.** This is also the right position for walking.

A sprain means that a ligament has been stretched and partly torn, or that one of its ends has been torn partly or wholly from the bone. It is sometimes more serious and harder to recover from than a broken bone. Rest and patience are needed while the parts are growing together again. Proper care of our bodies is always wise. Who more often have sprained ankles, boys or girls? Who wear broader heels to their shoes? Who take more exercise?

A dislocation means that a bone is out of its place at the joint. The bones of the spine are sometimes slightly dislocated when a rude or thoughtless child withdraws a chair from some one who is about to sit down.

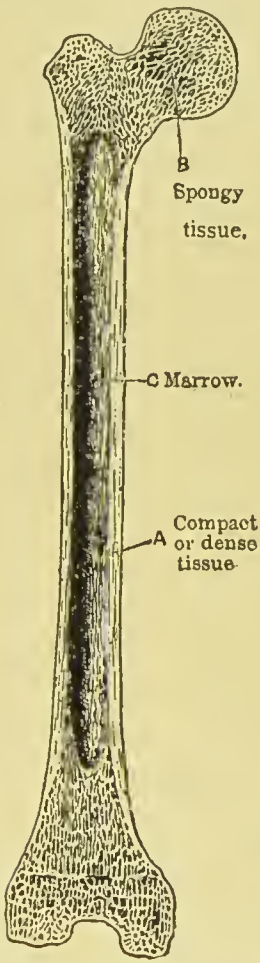


FIG. 14. — A Hollow Bone. The femur, or large bone of thigh, showing two kinds of tissue and the marrow cavity. Which end forms a ball and socket joint? A hinge joint?

If a baseball bat is broken, you repair the break by wrapping wire around it. If a pitcher is broken, you may glue it together. But a **broken bone** heals itself if the broken ends are placed in proper position. It must be kept in place with splints until it heals. The healing usually takes five or six weeks, but the bone is weak for a still longer time; a person with a broken bone should be careful for several months. After it is firmly healed it is so strong that the bone is just as likely to break again at another point as in the same place. If the wire is taken from the bat, the pieces come apart, showing that the broken pieces have not united like a broken bone.

The body is more wonderful and convenient than any house. With proper care it repairs itself and keeps itself in order. The bone, in life, is covered with a tough coat through which blood vessels enter

and carry the blood that enables the bone to repair itself. When bones of a drunkard or of a sickly person are broken, more time is required for them to unite than for those of a well or a temperate person.

When a bone is healing, at the end of the first two weeks the new bone that is forming is only a kind of jelly. The harder part, called the mineral matter, is deposited later.

Bones are composed of two kinds of matter, — the **animal matter**, which is like gelatine and glue, and the **mineral matter**, which is somewhat like limestone. Why cannot a bone be destroyed by burning it? Did you ever see a piece of bone which had been in a fire a long time? Was it more or less brittle than before? Was it lighter or heavier?

The bones are two thirds mineral and one third animal matter, or gelatine. The animal matter can be removed by boiling or by burning. The animal matter, gelatine, remains in the water after the bones are taken out; the water and gelatine after cooling take the form of the vessel. Glue is made of gelatine.

The mineral matter may be removed from a bone by soaking it in strong vinegar. Take a hog's rib or the leg of a fowl and soak it for three days in very strong vinegar. You can then tie the bone in a knot! Your teacher may then wash the vinegar away and keep the bone in a bottle of glycerine, or in a bottle of alcohol and water. There is less mineral matter in young children's bones than in the bones of older people. Why should babies not be urged

to walk? What deformity may result from walking too early?

Since the bones of older people contain less animal matter they are more brittle than the bones of children. Why should young people help old persons over rough places? What is the use of each of the kinds of matter found in bones?

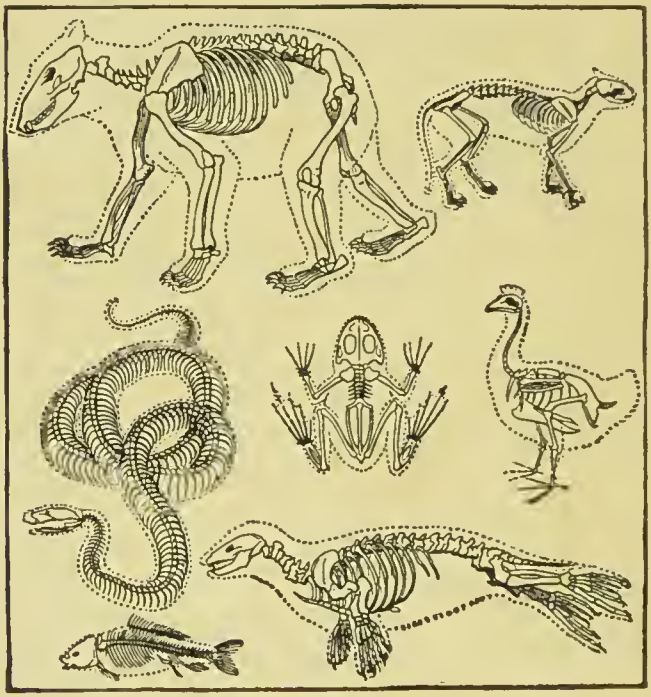


FIG. 15.

Can you name each animal whose skeleton is shown above? Has every one of these animals a backbone? Shoulder blades? One bone in first joint of limbs? Two bones in second joint of limbs? Which ones have finger bones and toe bones?

CHAPTER II

THE BRAIN AND NERVES

Questions you can hardly Answer.— "Why do you become hungry every few hours, eat food, and drink water? What is food? Why are some things 'good to eat,' and others poisonous? What happens to the food that you swallow? Why does a man become thin and weak if starved, or poorly fed? How is it that your body is always warm not only in summer time, but on the coldest winter days? Why do you feel hot when you run? why do you then pant for breath and why does perspiration make your skin quite wet? Why does your chest rise and fall about sixteen times a minute? Why do you breathe in air and then 'puff it out' with the help of these movements? Why do you choke if you grasp tightly the front of your neck with your hand and why does a man soon become choked if shut up in an air-tight box? Of what is the blood, which you see whenever you cut yourself, composed? What is the heart doing when you feel it beating against the left side of your chest? What is the pulse which you can feel throbbing in your wrist? How do the eyes see, the ears hear, the tongue taste, the nose smell, and the skin feel? Lastly, how is it that you can move

the parts of your body, walk, run, and train your hands to skilled uses?"

The Science that Answers these Questions.—These were the questions put by a teacher of physiology in England to a class beginning the study. Arithmetic, grammar, and geography help us to answer many useful questions. Physiology helps us to answer questions like those above. I think you will agree that there is no more useful study than physiology. For, after studying it, you will probably be able to answer every one of the questions, although you cannot answer one of them now.

Physiology teaches us about ourselves, how we live, and how the parts of the body called **organs**, such as the bones, muscles, heart, and lungs, do their part in helping us to live. The special duty or work that each organ has to do is called its **function**. The science of health is called **hygiene** and it is founded upon physiology. In studying physiology and hygiene, we are learning how to keep healthy and how to regain health if it has been lost.

Many wonderful things also are learned in this study. Some of the most wonderful are about our moving and thinking. Suppose your teacher says "Fold your arms"; you know what to do because she told you. But suppose the teacher says, "You may each do something without my telling you." How many different things would be done! Who told John to put out his tongue, or Mary to nod her head? No one. The thought of doing so came from their own brains and there the actions started.

FIG. 16.—The Brain, the Spinal Cord, the Nerves.

The Brain. — Can you describe a cow's brain, or a hog's brain, that you saw in the kitchen or at the meat market? What can you say about the color of the outside? Of the deeper portions? Was it smooth or uneven? Strange to say, such brains look very much like our brains, but they are not so large as ours. Some one has said that the many wrinkles and foldings of the outer gray part of a man's brain look like the kernel of a hickory nut or a walnut.

The **brain** is the part of the body in which the mind works. It is here we think, and feel, and will. It is to the body what the general is to the army, or the mayor is to the city. The Chinese suppose that the soul is located in the stomach. We do not merely suppose, we know, from what men who study physiology have proved, that thinking and willing are carried on in the brain. But do not therefore conclude that there is no mystery about thinking and willing. There are many mysteries about our minds and our bodies; we do not know what the mind is, or how it is connected with the brain. Physiologists have solved many questions, but there are many more that they, and all the other scientists, have failed to solve.

FIG. 17. — A Well-developed Human Brain.

How the Brain controls the Body. — Suppose you are asked to tap your foot on the floor and you do so. How is it that the brain causes the foot to

move although at some distance from it? The answer will be given you at once, lest you may think that this book has too many puzzling questions. It has been found that there are small shiny white threads, called **nerves**, made of still finer threads, called **nerve fibers**, which connect the brain with every part of the body. The brain sends an **impulse** along the nerve fibers down to the **muscles** in the lower part of the leg. This impulse through the nerve fibers causes motion in the muscles, and thus the foot is moved and the toes tap upon the floor. The mayor of a town can send messages to the firemen, policemen, or scavengers in all parts of the town by means of the telephone wires. He can receive messages likewise, and so can the brain. If any one steps on your toe, the news is carried to the brain, which superintends the body, by means of the nerves. Where these nerves leave the brain, most of them are together in a big bundle called the spinal cord. Did you ever see the marrow in the back bone of a hog? That was the hog's spinal cord. How large was it? A man's spinal cord is somewhat larger than a lead pencil. Smaller nerves branch from it and connect it with every part of the body.

Questions to Think Out. — How do we know that a nerve goes to every tooth? How can you know that a nerve goes to the root of every hair? How can you know that there is no nerve in the hair? How can you show that nerves go to two places on the skin only a hair's breadth apart?

The Two Kinds of Nerve Fibers. — The nerves carrying the impulses which set the muscles to working are called nerves of motion, or **motor nerves.** The nerves that bring impulses from the skin, eye, ear, or any part of the body and cause us to feel, are called nerves of feeling, or **sensory nerves.** No doubt you have had your foot "go to sleep." This was because you sat in such a position that the nerves were pressed upon and paralyzed for a time. The impulses could not pass and the foot could scarcely move or feel. If all the nerves had been interfered with, the foot would have been completely paralyzed for a time.

How to find where the Sensory Nerves Abound. — Take a cork and thrust two pins into it so that the heads of the pins will be about one fourth of an inch apart. Blindfold a boy, or get him to turn his head and look in another direction. Find out if he can tell whether you touch the back of his hand with one pin head or with both. Try the finger tips next. Thus you can find which part of the skin has most nerve fibers. The place with the greatest number of nerve fibers gives the brain the most accurate report about the pins. On some parts of the skin the sensory nerves are so numerous that the two pins can be felt if only a small fraction of an inch apart. In other places they are felt as one pin unless they are separated an inch or two. Test the sensitiveness of the wrist, the arm, the back of the neck and other parts with the cork and pins, moving the pins farther apart when it is necessary to do so in order that they may be felt as two.

A Curious Experience. — Once a boy was careless in handling his gun and it discharged accidentally, shattering his right hand. The doctor had to amputate (cut off) the arm below the elbow. One day the boy's right hand itched, as he thought, and he reached over to scratch it with the other hand. He was startled for the moment by not finding it there. Crossing a footbridge one day he reached toward the trunk of a tree as if to steady himself with his right arm, and fell into the water. You will soon learn how he came to make this mistake. After several years the ghostly hand stopped itching and he no longer thought of it as being on the arm.

When a Finger itches, where is the Feeling? — It is natural for us to suppose that it is in the finger. But the incident of the boy who lost his hand shows that the itching seems to be in the finger even after it is destroyed. We therefore conclude that the itching never was in the finger, but in the brain. The mind thought of it as in the finger, because every time impulses came to the brain along certain nerves they were found to come from that finger. An infant has to learn such things gradually, and may burn his finger in the candle without knowing whether to move the hand or the foot to stop the pain. When the boy's hand was first cut off, any itching in the stump was, from habit, referred to the hand, until this habit of the mind was gradually overcome. Many old soldiers found that the scar made when an arm or leg was amputated, drew together the skin too tightly in healing, and caused

constant itching, seemingly in the foot or hand. The thing to do was not to dig up the buried leg or arm and place it in an easier position, as some people foolishly believed, but to make a slight gash and allow the scar, in healing a second time, to cover the part more loosely.

The "funny bone" is so called because striking the nerve that passes over the bone at the elbow causes a tingling that seems to be in the fingers. Cross two fingers and touch the tip of the tongue with them. Why do there seem to be two tongues? Because heretofore when these two points on the fingers were touched, we found that two objects located a short distance apart were touching them.

Voluntary and Reflex Action. — Did you ever accidentally touch a hot stove, or other object, and find your hand jerking itself away vigorously without any effort of the will? Did you ever dodge or shut your eyes when you were trying to remain perfectly motionless? Such acts carried on **without any effort** on your part are called **reflex acts.** Acts that are performed by an effort of the will are called **voluntary acts.** In reflex action the impulse passes along the sensory nerve to small bodies in the spinal cord, called **nerve cells,** and comes back along the motor nerve to the muscles. Such acts are quickly performed, and many times save the body from injury when a voluntary act would take too long a time. Did you ever see any one kill a chicken? What did you see to convince you that

reflex action could take place without the aid of the brain? If the chicken stops jumping, how can you start it jumping again? Why does this make it jump?

In a copy of the following list, show to which class of acts each one belongs by writing R before reflex acts, R V before those which are either reflex or voluntary, and V before those which are voluntary.

winking	hiccoughing	smiling
walking	chewing	jumping
coughing	vomiting	the beating of the heart
dodging	seeing	
laughing	throwing	breathing
talking	swallowing	blushing

A Busy Brain and an Idle Brain. — You all know that the muscles grow strong and steady by using them properly. Likewise, the brain and nerves grow sound, vigorous, and active through use. The idle boy's brain will not grow strong as does that of the wide-awake, thinking boy. If the brain is often confused by strong drink, the mind loses its clearness. If the hands are trembling and unsteady from smoking cigarettes, the nerves never have the strength they would have had if they had not been poisoned by the use of tobacco.

Habit. — The brain and nerves can be trained not only for strength, but they can also be trained into good or bad habits. **A habit is formed by doing a thing repeatedly in the same way.** Suppose you allow yourself to fret or worry, or whine when things go

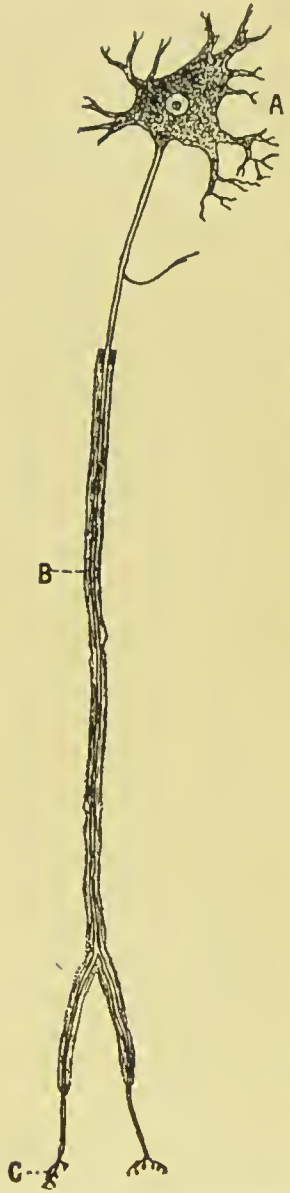


FIG. 18. A Nerve Cell, A, and a fiber from it, B. The fiber has a white, fatty covering. A reflex action can take place with two cells, each having a long branch, and connected by their short branches.

wrong. When you grow to be a man or a woman, is it likely that you will be brave and cheerful when trials come, and patiently struggle until you triumph over them? If you get angry frequently, will you be strong and self-controlled when you grow up, or will the habit of losing your temper be likely to remain with you all your life? You can even help to make yourself sick by worry; you can help in getting well by being cheerful.

Alcohol acts upon the little bodies called **nerve cells**, found chiefly in the spinal cord and brain. **The cells** shrink and shrivel to a smaller size. Some of the **fibers** that branch from the cells **first swell up**, then become **knotty** and **waste away.** It is no wonder that the drunkard acts like a crazy man and is sick at the end of his spree. Neither is it surprising that he loses his strength and industry and shortens his life. It was formerly supposed that the changes in the nerve cells and fibers resulted from the continued use of alcohol. Men have

found by examining a rabbit's brain, after compelling it to take alcohol, that this condition occurs the first time alcohol is used. Although the brain may almost recover from one poisoning by alcohol, it will never entirely recover. It is not wise to drink alcohol even once, if we care for the health of the delicate substance of the brain. Alcohol, by injuring the brain, weakens the mind to such an extent that insanity may result. The fighting and the base crimes committed by drunkards prove that they are temporarily insane.

Rest and Sleep. — Idleness and excitement weaken the brain, but regular work strengthens it. After using the brain, we must allow it to rest. Sleep is the time when tired nerves, brain, and muscles rest. Children need more sleep than grown persons because they are growing and are so very active while awake. A child who is weak or sickly in body, but active in mind, should be taken out of school and allowed to work and play out of doors most of the time. Fresh air and exercise increase strength and health. Some parents allow weak children to study too hard in order to get ahead of children of their own age. This often results in vain and foolish as well as sickly children. A healthy child should study more than a sickly one.

How do Rest and Sleep help the Brain? — Sleep gives the blood time to repair the waste of the body. You will soon study about the blood and learn how it does its work. You will learn that it flows through blood vessels to all parts of the body.

carrying the food which has been prepared by digestion and the oxygen which is obtained from the air in the lungs. At the same time that the blood takes nourishment to the organs, it carries away the used-up materials, the waste matter. This explanation gives the reason why sleep is so refreshing.

AN INDIAN STORY

Once upon a time there was an Indian who went on a long journey to get flints with which to make arrow heads. The country of the Flint Rocks was many, many hundreds of miles from his own country.

After getting the flints, he started home. His supply of parched corn and smoked venison failed when he had many days' journey before him; so with his tomahawk he dug up roots of plants for food and traveled on. But the roots were so poor a food that he became very weak and hungry. He began to chew the leaves also. By the side of the trail he found growing a tall weed that bore large, fleshy leaves. He plucked several of the leaves and ate them, but they had a burning and bitter taste.

Soon he felt so faint and sick that he staggered as he walked, and sinking down at the foot of a large tree, he murmured to himself that he would never see his squaw or his papooses again. He tried to rise but fainted away.

Meanwhile, the warriors of the tribe, thinking he had been long on the journey, started out and found him under the tree. They gave him food and carried him to his wigwam.

When he recovered, he told the medicine man of the tribe that he believed it was eating the plant with the fleshy leaves and bitter taste that had made him give way on the journey. He showed him the plant and the medicine man ate some. It made him sick too. So the medicine man said to himself, there must be some great charm or power in the plant. The Great Spirit has given it a bitter taste and sickening effect in order to keep man from eating it and gaining this power. So he dried it and chewed a little day by day, and found that it ceased to make him sick. He grew fond of the plant; it made him feel so dull and dreamy that no trouble gave him any uneasiness. The young warriors all learned to chew it. After a while the medicine man found that if he ceased chewing the weed, he felt miserable and uneasy without any cause. He grew so weak with age before his time that he could not follow the war path but had to stay at home with the squaws to take care of the camp. He told the young warriors that the plant had weakened him, but that he could not do without it because it had mastered him. But they would not believe that a weed could hurt them.

When the pale faces came to America from across the sea the Indians told them of the plant that gave strength, as they believed. The white men also began to use it. They knew no more about the Great Spirit than the Indian, and they thought that the Great Spirit made good things and hid them from men by bitter tastes. In this they were greatly mistaken. God has made the good things pleasant to the taste,

and the poisonous things repulsive to the taste, in order to keep man from eating them and injuring himself. But man is headstrong and wise in his own conceit and thinks he knows better.

The white men as well as the Indians learned to smoke this weed. Can you tell the name of the weed?

FIG. 19. — The Tobacco Plant.

CHAPTER III

THE BREATHING

We breathe all the time, awake or asleep, but the breathing usually goes on so quietly that we do not notice it. Hold one hand near the nose and place the other on the chest. When the air comes out of the nose, what happens to the chest wall? What happens to it when the air goes in? Find out in the same way what happens to the waist and to the abdomen. As the body walls move outward by the action of the muscles, the size of the chest increases and the air rushes in to fill the empty space. When the walls move inward, the air is driven out again.

The chest measure is the distance around the chest. Get the tape measure from your mother's sewing basket and find your chest measure. The difference between the size of the chest fully expanded and contracted as much as possible is called the chest expansion; and the difference in the measurement of the waist expanded and contracted is called the waist expansion. (See Fig. 20.) Would you like to know your waist expansion? Your chest expansion? By standing before a mirror you can find your own chest expansion. Read the tape measure when the chest is contracted and let the

measure slip through your fingers until the chest is fully expanded, then read it again. Subtract the first number from the second; the remainder is your chest expansion. Which boy and girl in the class have the greatest expansions?

NAME OF PUPIL	WAIST	CHEST
Measurement when expanded		
Measurement when contracted		
Difference between measurements, or waist expansion and chest expansion		

Sometimes boys make the muscles on their arms swell and harden to see who is the strongest. A better way to test strength is to measure the size and expansive power of the chest. **The boy with the greatest chest expansion** is able to run faster and longer without becoming tired. He can hold out longer in any kind of work or exercise, and can sing, speak, and think better. He feels stronger and better than a boy with smaller chest expansion.

FIG. 20. — This little girl is finding how much her chest expands. She is using a tape measure before a mirror.

Respiration is another name for breathing. It consists of an inspiration and an expiration. In an inspiration the air rushes into the lungs; in an expiration it is driven out again.

How the Muscles enlarge the Chest. — During inspiration the chest moves upward and outward. This movement is made by the muscles lifting the ribs. If you are not fleshy, you can, with the fingers, feel the ribs move up and out during an inspiration, and down and back during an expiration.

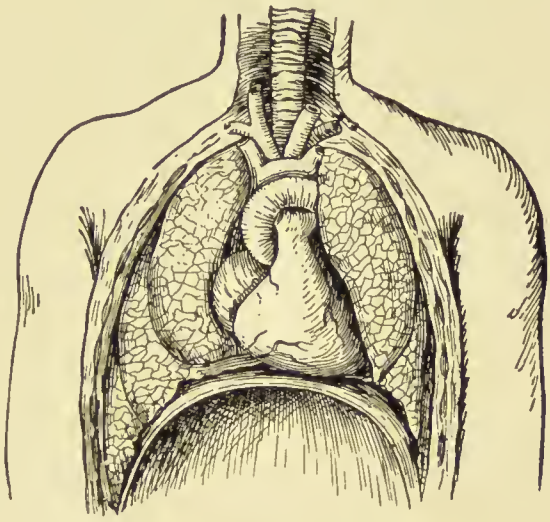


FIG. 21. — The Lungs and Heart. The diaphragm is shown separating the chest above from the abdomen below.

But the hollow cavity of the chest also enlarges downwards. This result is due to another muscle, the broadest and flattest in the body, called the diaphragm (di'a-fram). The diaphragm forms the floor of the chest and divides it from the abdomen, the lower part of the trunk. The diaphragm is hollowed upward like a bowl turned over. By contracting, it flattens and forces down the organs into the abdomen, increasing the space above. At the same time the abdomen expands or swells out a little in front and at the sides to make room for the organs forced down

by the diaphragm. Draw a deep breath and find out whether the abdomen enlarges or diminishes during an inspiration, — during expiration.

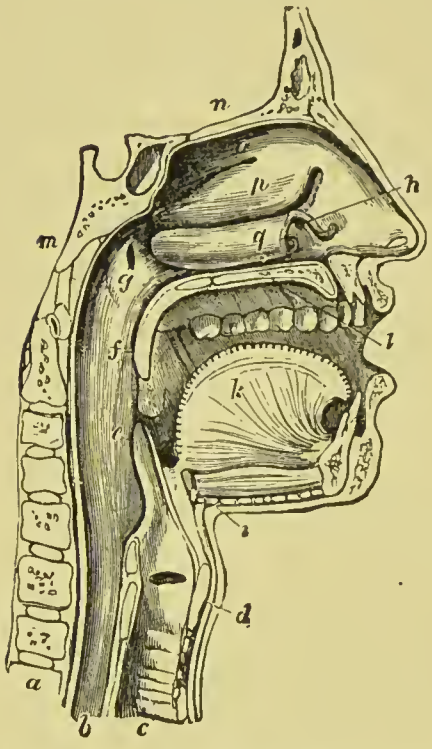


FIG. 22. — Showing portions of the nasal passages, mouth, throat, and windpipe.

a, spinal column; *b*, gullet; *c*, windpipe (lower part); *d*, windpipe (larynx); *e*, epiglottis; *f*, soft palate and uvula; *k*, tongue; *l*, hard palate.

Where do you feel the muscles contract when you cough? When you laugh? Those you feel are the muscles in the walls of the abdomen contracting and forcing the stomach and liver up against the diaphragm. Does the breath go in or out in coughing and laughing?

Why we Breathe. — Perhaps you do not know why we breathe. We breathe for the purpose of taking into the body the part of pure air called oxygen and for the purpose of sending the impure air out of the lungs. The oxygen makes the blood bright red although it may have become dark owing to the impurities contained in it.

We can **breathe through either the nose** or the mouth, but it is better to breathe through the nose. There are hairs in the nose which catch the dust

and keep it from going into the lungs. When the weather is cold, breathe through the open mouth and notice whether you can feel the cold air in the throat. By taking the air through narrow passages, the nose warms the air before it reaches the delicate organs. The air goes from the nose to the throat, where a little trap door made of gristle covers the entrance to the windpipe. When this door is lifted, the air enters the windpipe.

The upper end of the **windpipe** is a kind of box (the larynx) made of gristle, called "Adam's apple." You can easily feel it in your throat. When you swallow, this organ moves upward, bringing its upper end under the root of the tongue. This aids the trap door, or lid, in preventing food and drink from going into the windpipe. Across the gristly box, below the lid, two elastic strips are stretched. These strips are called the vocal cords. As the breath coming from the lungs passes through the opening between these cords it causes them to vibrate, thus producing the voice if the cords are close together and drawn tightly. Feel the windpipe below the "Adam's apple." Is it smooth or in ridges? It is made of rings of gristle, which keep the windpipe open so that we may not choke or smother if anything presses on it.

The Lungs. — About four inches below the throat the windpipe begins to branch, looking like a tree turned upside down. It first divides into two tubes, and these in turn divide into still smaller tubes, called **bronchial tubes.** This branching occurs a

number of times and the smallest tubes end in a number of little air cells. These cells are round and are arranged on the ends of the air tubes like bunches of grapes. In these cells the true function of breathing is performed. The walls of the cells are as thin as tissue paper. Into the tiny blood vessels between the cells part of the fresh air, called **oxygen**, passes and is carried along by the **blood**. At the same time some of the **impurities in the blood pass** through the thin walls into the air cells and are carried out in the breath. All these tubes and cells taken together form the lungs. The lungs are so light when partly full of air that they float if thrown into water. The many tubes brought to view when the lungs are cut give them the appearance of a sponge; but the tubes are arranged in a more orderly manner than those in a sponge.

Why we need Lungs. — Do you know what the lungs are for? Why do we breathe? You say to supply the blood with oxygen and to take away the impurities. But why is it necessary to supply oxygen? What are the impurities that are taken away? If you will try the easy experiments given below, and think carefully about what you read, you will have no trouble in understanding the work of oxygen. Its work is most important, for without it we could not live. No one knows what life is, but we do know that the process called oxidation is at the basis of life.

Below are some experiments which will teach you what is meant by oxidation.

Experiments. — Get a large glass jar, a short candle, and some matches.[1] Light the candle and put it on the table, near the edge, covering it with the glass jar. The flame slowly smothers and goes out. Why is this? Is the air now in the jar different from that which was in it before the candle was

FIG. 23. — Breathing into a jar through a tube or hollow stem, passed through a card. What happens to a lighted candle inserted into the jar? Explain this.

FIG. 24. — The bottle has been inverted on the table, the card slipped away, and the lighted candle lifted into the bottle to see whether it will still burn.

lighted? Some change must have taken place or the candle would continue to burn. Do you think the candle will ever burn again under the jar without changing the air? Let us try an experiment. Slide the jar to the edge of the table and let the candle drop out. Light the candle and slip it up into the jar again, the jar being held with its mouth a little over the edge of the table to receive the candle. (Fig. 24.) The flame goes out at once.

[1] The teacher cannot expect the pupils to understand what oxidation means if these experiments are omitted.

Evidently the air in the jar is not the same as the air outside. Take up the jar and wave it to and fro a few times, so as to change the air. The candle now burns in it again with a bright flame as at first. So we conclude that the candle will not continue to burn unless there is a constant supply of fresh air.

Carbon Dioxid (dī-ox´īd). — If you should pour some clear lime water into the bottle after the flame goes out, the lime water would become white and milky. This shows that there is a new gas in the bottle. This gas (carbon dioxid) is formed by the union of the oxygen of the air with the carbon in the tallow. The oxygen of the air in the bottle is used up in forming the carbon dioxid, so the candle does not burn. Oxygen, therefore, is the gas which makes it possible for a fire to burn. The union of oxygen and other gases is accompanied by heat, and sometimes by light; it is called oxidation. Carbon dioxid is a gas that prevents anything from burning; this gas smothers fire. Here we come to the important point. The fresh air going to the lungs carries oxygen with it, but the air we breathe out has much carbon dioxid and very little oxygen.

Another Easy Experiment. — Let me tell you how to prove that our breath is as impure as the air that smothered the candle. Place a cardboard over the mouth of a bottle containing pure air. Take a long straw, the hollow stem of a weed, or a sheet of stiff paper rolled into a tube, and pass the tube into the bottle through a hole in the cardboard. Now

send one long breath into the bottle through the tube, emptying the lungs by this breath as near as possible. (Fig. 23.) Place the bottle on the table as in the former experiment, afterward withdrawing the cardboard. Move the bottle to the edge of the table and pass the lighted candle up into it. Does the flame go out as quickly as in the former experiment? If you breathe through a tube into clear lime water, the water turns milky. What does this prove?

Sometimes carbon dioxid is found in wells. It is then called choke damp. If a lighted candle lowered into a well continues to burn, it is safe for a man to go down into the well. Air that is so impure as to put out a candle would soon smother a man.

Oxidation in the Body. — The air which we breathe out has much carbon dioxid and very little oxygen, because carbon dioxid is constantly forming in the body of a human being as well as in the flame of a lighted candle. The food we eat corresponds to the tallow in the candle; the air furnishes the oxygen for the candle flame and for the human body. Oxidation gives rise to heat and motion. If the oxidation is rapid, as in running, the heat is comparatively great. The oxidation in the body is much slower and at a lower temperature than the oxidation in the candle flame. The colder the weather the more food we use to keep up the heat of the body.

Charcoal is almost pure carbon. Nearly all foods contain some carbon. That there is carbon in sugar

can be shown by putting sugar on a hot stove or a hot shovel. The water in the sugar is driven off, and the black charcoal remains. Corn turns black when it burns, and so does bread if it is left in the oven too long. If this bread had been eaten before it was charred, it would have been oxidized in the body by the oxygen brought in by the lungs. Part of it would have formed carbon dioxid and would have been exhaled. For some reason we cannot eat and digest pure charcoal as found in charred sugar or bread.

FIG. 25. — Breathing through lime water.

When you are older and study chemistry you will learn about many other substances besides carbon and oxygen. You will learn that although one fifth of pure air is the active gas called oxygen, about four fifths of it is an inactive gas called nitrogen. Nitrogen does not readily unite with other elements. If you hold a piece of cold glass above the candle flame, or if you notice a lamp chimney when the lamp is lighted and before the glass has had time to become hot, you will see moisture collecting on the glass. This has been formed by the union of the oxygen of the air with the hydrogen that was in the tallow or oil. Hence water, a liquid, is made up of these two gases. Water is thus formed by the oxidation of hydrogen in our own bodies. Some of the water that forms a "cloud on the

breath" on a cold morning, or the water that collects when you breathe upon a cold window pane, is formed in the body in that way.

Oxidation, the union of oxygen with other substances, may take place rapidly and cause great heat, as when a log burns: it may also take place slowly, as when wood rots; but even then it is accompanied by a little heat, and sometimes by light, as you may have noticed. (You probably called it "fox fire.") When iron oxidizes, rust is formed. Rusting is oxidation. The oxidation that keeps up the heat and strength and life of the body is of the slower kind. In the moist body, oxidation takes place slowly.

A Comparison. — Do you know of anything besides an animal that is warm and moves? It needs a continual supply of fresh air and fuel in order to move. If the supply gives out, it becomes cold and motionless. Likewise, it uses only the active oxygen of the air, not the lazy nitrogen, and fuel takes the place of man's food. No doubt the boys can tell what it is. It is called a l——. It differs from an animal in many ways, the chief difference being that an animal can control his actions. It needs to be controlled when it is moving.

Review Questions. — Where is the organ located that controls all parts of man's body? What is a nerve? a nerve fiber? Is breathing voluntary or involuntary, or may it be either? What is a reflex action? What is a voluntary action? Where is the spinal cord? How can you prove that feeling

is not in the fingers? What is the effect of alcohol upon the nerve cells? upon the nerve fibers? upon the mind? How is a habit formed?

A SHIP IN A STORM — ITS IGNORANT CAPTAIN

"There was once an emigrant ship that sailed from Liverpool. The men and women and children on board were going to leave England to work in a strange land. One night a dreadful storm arose. The ship tossed about so much that the captain ordered the sailors to send all the men and women and children down into a large room under the deck, because he was afraid they might be in the way. The sailors fastened the doors so that they could not get out. The storm went down in a few hours, when the captain told the sailors they might open the doors, or hatches, as they were called. The sailors took a candle, because the room where these poor creatures were put was quite dark. When they entered, the candle went out. They lighted it again, and it went out a second time. This was done several times. At last it remained alight, and so they were able to descend. And what do you think they found? Nearly all the men, women, and little children lying on the floor — some of them dead, others unconscious. The only air they had had to breathe was the air that had come out of their mouths. And as that was *not* fresh air, it had poisoned them.

"This is a sad story, but it taught a great lesson, for no one now puts either people or animals into

rooms where fresh air cannot get in; though few people, even among those who know something of physiology, are quite as particular about methods of getting fresh, clean air into their houses as they should be.

"It was because the air was dirty, or poisonous, that the people shut up in the ship died, for our bodies need all the oxygen that is in the air. Each time any of these poor people took in a breath, more of the wholesome oxygen was used up; each time any of them breathed out a breath, more of the poisonous carbon dioxid was in the room; and the absence of the oxygen and the presence of the carbon dioxid was what caused some to die, and others to become unconscious." [1]

REVIEW LESSON. (*Health of the Bones.*) — How is the backbone constructed so as to prevent jarring of the head? Why cannot a person who has become round-shouldered become straight again in a very short time? What may be the effect of alcohol and tobacco and other poisons upon the growth of the bones? Name four things besides food that are good for bones. Is a cigarette smoker usually as large and strong as other boys of the same age? Does his skin look as fresh and clean?

What is the right position when sitting in a chair? What is the right position in standing and walking? While walking, which should be further forward, the hips or the chest?

What is a sprain? Why should it be considered a serious accident? What is a dislocation of a bone?

[1] "Health in the House," by Mrs. Buckton.

CHAPTER IV

HYGIENE OF THE LUNGS

How the Lungs are injured by Alcohol. — We may smell alcohol in the breath soon after it has been swallowed. This is because the alcohol has made its way into the blood and the lungs are doing their best to remove it. The alcohol in wine, beer, and whisky hardens and thickens the walls of the delicate air cells so that they cannot do their work well. The oxygen and carbon dioxid cannot be exchanged so rapidly through the thickened walls of the air cells. Alcohol also weakens the blood vessels in the lungs, so that they readily swell and become the seat of inflammation, such as pneumonia and bronchitis. (An old drinker sometimes breathes and speaks with a wheezy or hoarse sound because of the hardening of the air cells and the injury to the vocal cords.)

Doctors formerly thought that alcohol was a cure for consumption. It is now known that it does not afford any relief to one suffering with consumption. The injury that alcohol does the lungs sometimes brings on an incurable form of the disease.

Tobacco and the Lungs.— If the walls of the tubes and air cells of a man's lungs could be flattened and placed side by side, they would cover a surface equal to the walls, floor, and ceiling of a small room.

Smoke from a pipe or cigar is not usually inhaled because the poison is too strong. Most of the smoke would be coughed up before it went farther than the windpipe. If a man or boy smokes cigarettes, the weaker smoke can be drawn into the lungs, or "inhaled," as it is called. Which does the greater harm, weak cigarette smoke in the large and tender lungs, or strong tobacco smoke in the tougher mouth? Instead of having strong, well-developed lungs, cigarette smokers often grow up with weak and flattened chests; severe pains in the chest frequently result. The habit of smoking cigarettes often grows on some people so that they smoke dozens in a day. Such smokers are sometimes killed by the habit in a few years.

A boy named James B—— in a certain town died from the effects of cigarette smoking, the habit being so strong that he smoked them on his deathbed. The day after his funeral, two boys went into a store to buy cigarettes, and asked the salesman to give them the same kind of cigarettes that killed Jimmie B——. Were these two boys brave boys or simpletons?

A smoker may be offensive to others because of the disagreeable odor from his clothing and the disagreeable manner in which some who smoke indulge in the habit. They force all who sit or pass near to submit to a sickening odor. They do not take the trouble to remove the odor that the tobacco leaves upon their clothing and bodies, if indeed it could be removed at once. They spit upon

the floors of cars, stations, courthouses, and hotels. Too frequently a man with a vile pipe or cigar sits so that the wind carries the odor of the tobacco to others who have been wise enough not to form the habit. In Mexico people smoke even in the theaters.

The body is the dwelling place of the soul, and no one has a right to injure even his own body.

It is a public danger to have people carrying fire about and dropping lighted matches and cigar stubs. Millions of dollars' worth of property has been destroyed as a result of this habit.

Thought Questions. — Answer the following questions, remembering that the oxygen of pure air, after it enters the body, burns the food and thus keeps the body warm. It gives us strength with which to move and think and work.

Touch the iron frame of the desk. Feel your neck beneath the collar. Which is warmer? What causes this difference?

Why does staying out in the fresh air give a good appetite? Why does it make us still more hungry if the air is cold as well as pure? Why do we eat more in winter than in summer? Why does living in close, unventilated rooms cause a person to lose his appetite? Why do you get hot when you exercise? Why should babies carried in the arms be clothed more warmly than older children?

Why should you breathe deeply? Which causes you to breathe more deeply, moderate or violent exercise? Which causes you to expand the lungs

more, running or walking? Which develops the lungs more?

Why should a person who faints in a crowded house be carried into the open air to recover?

How can you put out a fire in the stove without using water? How can you tell by the touch that an animal is dead?

Have you noticed that you can learn a lesson better after recess than before? Is a headache ever cured by going out into the fresh air?

FIG. 26

Developing the Lungs. — If a person does not have healthful outdoor occupation, it is well to form the habit of taking deep breaths in the open air for a few minutes twice each day. Throw the windows wide open; stand with head erect and chest up; draw in just as much air as possible, allowing the walls of the chest and abdomen to expand. After a few seconds allow the breath to escape slowly, until the lungs are emptied. Keep up this deep breathing for five minutes. If one were to do this every day, his lungs would become so large and strong, and his blood so pure, that he would have no need to fear lung diseases. Such a person would seldom have a bad cold.

How does breathing purify the blood? How do large lungs and deep breathing keep the blood purer than small lungs and shallow breathing?

How the Plants help us. — The carbon dioxid from our breathing and from the fires in our houses and factories is absorbed by the plants through tiny openings on the under side of their leaves, and the carbon is used to build up the plant. In turn, the plants, by the aid of the sunshine, send out the oxygen for man and animals to breathe. We should encourage the planting of trees and should take care of those that are growing, even of the commonest kind. The trees protect us from the heat of the sun in summer and catch much of the dust that, but for them, would be blown into our houses.

FIG. 27. — A man's suspenders should slide on a pulley at the back, so that, when one shoulder is raised, the suspender on that side may become longer as the other one becomes slack.

Other Impurities besides Carbon Dioxid. — What is called dust is very injurious to the lungs, so much so that the lungs of people who live in cities have a grayish tint, while people who live in the country have pink lungs. Dust consists of particles worn from stone, hair (from carpets), meat, cotton, wood, wall-paper, etc. Even the cleanest room, when kept closed for a number of days, has a close, unpleasant smell, which should be removed by a thorough airing before the room is used. Sometimes the houses in cities where poor people live are so tall and crowded that the fresh air and sunlight hardly reach the rooms to purify them. Cleanliness is more im-

portant there than in more comfortable houses. But often we find houses of people who are not poor, where the sunlight and fresh air are kept out of the rooms by dark curtains which catch and make more dust. Such people fear that the sunlight will fade the paper and carpets. They are often pale and unhealthy, and have such weak nerves that they easily lose their tempers, and make themselves and others unhappy.

What Unhealthful Homes lead to. — These persons are also likely to lose their appetites for healthful, unstimulating food, and to wish food highly seasoned, or to crave even stronger stimulants. People who live in unhealthful homes, whether rich or poor, are often downhearted, and many of them, for this reason, fall into the habit of drinking liquors to "drown their sorrows," as they think. "But alas! they may drown their souls, instead."

To live in houses that are dark and dusty or filled with bad air, is to destroy our appetites, strength, and healthful appearance. The health and happiness of one child is of more value than any number of carpets and curtains. No intelligent mother should allow her pride in fine things to cause her to put carpets into a bedroom or to use dust-catching curtains there instead of simple window shades. No room should be re-papered unless the old paper is first removed.

Notice the millions of particles of dust playing in the sunbeams that enter a dusty room. Go to the window and with a mirror send a beam of sun-

light across the room in search of dust in the air. The lungs of a coal miner were found, after his death, to be as black as coal itself. Another man coughed up coal dust seven years after he stopped working in the mines.

Impurities from the Body Itself. — But the impurities coming from the breath and skin of a human being are often more injurious than the dust from furniture. Would you like to try **an experiment** with your own breath? You know that carbon dioxid is a colorless, odorless gas. Breathe several times into a bottle and quickly cork it up air-tight. After a few days remove the cork and smell the air in the bottle! The odor arises not from carbon dioxid, but from particles from the digestive organs, nose, lungs, or teeth, that pass off in the breath, and have decayed in the bottle. Impure air in churches and schoolhouses causes headaches, sleepiness, and dullness.

Ventilation. — Some persons think that if a bedroom is aired once a day the air in it will be pure; but this is not enough. While any one remains in it, whether in the daytime or at night, the air is all the time being made impure; hence the air should be changing all the time. The air of a closed schoolroom becomes very impure and unhealthful in ten minutes.

To prevent a draft, a board as long as the width of the window may be put on its edge under the lower sash after slightly raising the latter, the board filling up the opening. The air will come in between the two sashes and be turned upward.

Another way to prevent drafts, and the easiest way, is to open the window only a fraction of an inch. The draft cannot be felt more than a foot or two from the window. Some people who have never tried very small openings in a window, think all small openings make drafts that "cut like a knife." If the people who are so fond of raising windows high and chilling every one would hold a hand to a small opening in cold weather, and remember that the opening is many times as large as the combined size of all the nostrils in the room, and that the air enters the opening more briskly than it is inhaled, they would see that there is enough ventilation. Sometimes one eighth of an inch is enough, if the weather is very cold, and there are only two or three people in the room. Air always enters an opening more rapidly in cold weather because there is a greater difference between the temperature outside and in the room. Why do we need more oxygen in cold weather than in warm weather? The force with which air enters an opening can be felt with the hand, or shown by dangling a thread before the opening.

The Black Hole of Calcutta. — Did you ever read the story of "The Black Hole of Calcutta"? In the year 1756, a cruel tyrant in India, having captured in war a hundred and forty-six Englishmen, forced them one hot night into a room with only two small windows, each about two feet square. Then he closed and barred the door. The prisoners soon began to suffocate, and to struggle and

fight for places near the windows. When at last the terrible night was over and the door was opened, only twenty-three were found alive. Most of these were in a crazed condition, and only a few of them ever regained their health.

How to ventilate a Room. — Ventilation should furnish air having two qualities: it must be pure and of the right temperature, neither too warm nor too cold. As you learned when studying about the wind in geography, cold air is heavier and settles, thus causing the warm air to rise. Its weight causes it to spread out and to displace the warm air. On this account, the coldest air in a room is near the floor, and there is usually cool air in the room moving along the floor toward the stove or fireplace. Because of this current along the floor, some people take cold if they wear slippers. Since the cold air goes from the opening to the stove, it is best to place the stove near a window and let the air enter through the window. The air should come in on the side of the house against which the wind generally blows in the coldest weather. The stove should be on that side. If the stove is near the inlet, the air is heated as soon as it enters. The outlet for the air should be on the side of the room opposite the stove, so that the warm, pure air must cross the room and give warmth and oxygen to the occupants before passing out. How can you ascertain whether the air is coming in or going out? If a window near the stove is opened at the top, the hot air, as it rises, passes out at once, and the warm air

does not circulate through the room. Some persons have mistaken ideas about opening windows at the top. The wisdom of ventilating in this way depends on the circumstances.

Ventilation and Sleep. — Many mothers have doubtless learned that when children are restless in their sleep, throw off the coverings and toss about, it is often because the air in the room has become impure with carbon dioxid. The nerve centers are poisoned, causing a struggle for fresh air. A window is opened, and one falls into a sweet, sound sleep. On rising in the morning, the bed-clothes should not be spread neatly over the bed at once, but they should be first thoroughly ventilated in the open air. Beds should always be well aired.

Correct Breathing. — You have learned that you must take long, deep breaths; also that you must breathe through the nose. If you sit or walk with the chest flattened, you do not get enough pure air, even if the room is perfectly ventilated or if you are out of doors. You have learned two reasons why you should not breathe through the mouth but only through the nose. The nose warms the air before it reaches the delicate lungs. The hairs in the nose catch the dust and prevent it from going into the lungs. There are other reasons. Breathing through the nose prevents short, shallow breaths. If, when running, you breathe only through the nose, you can run twice as far before getting tired. If you run, or take other hard exercise with the mouth open, you will soon be panting and gasping for

breath. Breathing with the mouth open develops a weak and unpleasant expression of the face. So —

"If you wish to grow healthy, wealthy, and wise,
Shut your mouth and open your eyes."

THE ARCHITECT AND HIS TWO FRIENDS

AN ALLEGORY

Once in the city of New York there lived a great architect. This architect had two friends who admired him for his wonderful wisdom and the greatness of his works. Both of the friends lived in houses which had been built for them by this architect. They found the houses to be most gracefully built and to possess a convenience of arrangement that was perfect.

One of them thought, however, that the foundation of his house was a trifle large in front, and built too straight in the rear, and it is said that he forced the pillars in front closer together, and slipped bits of leather or other flimsy stuff under the rear, and made it gracefully tapering and, as he thought, not at all top-heavy. The house showed great wisdom in its construction; but he thought the hall was a little too spacious, compared with the other parts, and that it allowed too much room for the movements of his family, and too much chance for strong drafts of air. So by means of metal stays and cables of stout fiber he drew in the walls of the hall, and in his opinion gave it a size that was proper for such a house.

He knew that the builder of the house was not only an architect of perfect skill but likewise of perfect taste, yet the material in the wall was not of the exact tint that the owner desired, so he painted it, and obscured the delicate natural tint of the wall. He hung heavy curtains upon the most delicate parts, overlooking the strong brackets and other parts more suited to the purpose.

He loved the house, for it was his home, and he loved the architect, who was his friend; but he allowed dirt and dust to accumulate around the door, where it would be blown in upon the finely finished interior. He even used the pantry as if it were a warehouse or storehouse and not a pantry. He was afraid the architect would not know how he appreciated the beautiful dwelling, nor know how wise he believed him to be; so he went sometimes as often as once a week to the house of his friend and told him what a great architect he was and how perfect was every work of his hand. In fact, his voice could be heard leading the chorus of praise and gratitude.

The other friend was also grateful for his beautiful home, and likewise believed in the wisdom of the architect. He let the foundation stay as it was. He liked the roomy hall and said that it gave freedom and pleasure to all the family. The architect often passed that way and often visited him in his house; and when the architect saw that the house was well preserved, and clean not only on the outer wall but in every passageway and pantry, and every proportion kept as originally planned, he saw that

the faith and gratitude of his friend were not hypocrisy. But whenever he saw a house, whether on broadway or street or avenue, that had been altered, or improvements attempted, according to the notions of certain foolish people, he knew that the owner believed more in such people than in him.

The name of the first friend was Fop, and the name of his wife was Style. The other friend's name was Truth.

This allegory is intended to teach reverence for the body as a work of God. What is meant by changing the foundation? By making the hall narrow? By misusing the pantry? Were Mr. Fop and his wife hypocrites or did they deceive themselves?

REVIEW LESSON. (*Health of the Nervous System.*) — What is the effect of use upon the brain? Why do the hands of cigarette smokers sometimes tremble? What is the effect of alcohol upon the mind? How is a habit formed? Name habits sometimes formed in childhood that are likely to remain when the child is grown. What is the effect of alcohol upon nerve cells? What is its effect upon nerve fibers? What is seen by examining a rabbit's brain soon after compelling it to take alcohol? What shows that a drunken man is temporarily insane?

How is the brain affected by (1) idleness, (2) work, (3) excitement, (4) sleep? Why do children need more sleep than grown persons? What should be done with a child with an active mind and a weak body? Explain how sleep refreshes the brain.

Tell the story of the Indian lost on a journey. Show how instinct is given us for our protection. Why are poisonous things repulsive to the taste? Why do good things have a pleasant taste?

CHAPTER V

THE BLOOD

You learned in the last chapter that part of the food is burned in the body like fuel in a stove. You were no doubt surprised and some of you may have asked yourselves the questions, "Is it worth while to put food into the body to have it destroyed? How can it burn in my body? There is no fire in my body!" You soon learned that it is not an ordinary fire. The bodily heat of 98 degrees, as shown by the thermometer, is one proof that oxidation is going on in our bodies. In the depth of winter, in the icy regions near the north pole, when the thermometer is 40 degrees below zero and the mercury itself freezes in the thermometer, man's heat is still 98 degrees, on account of this internal oxidation.

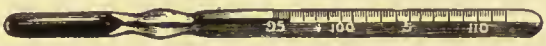


FIG. 28.—Thermometer for testing temperature of body by placing it under the arm or in the mouth.

Where in the body does this oxidation take place? It was once thought that the materials in the blood were burned up by the oxygen while the blood was passing through the lungs. Now it is known that the combustion goes on in the different organs to which oxygen is carried by the blood. Were all the heat of the body furnished by the lungs, the tem-

perature would be far too great for that organ. The fact is that the blood is warmer on entering the lungs than on leaving them.

If you cut the skin slightly, the blood flows out in drops; if the cut is large and deep, it flows in a stream. Why does the blood flow from a wound? If your hand is cut, the blood still comes out, even though you hold your arm above your head. Does it simply leak out of the cut, or is it pushed out? By placing your hand upon your chest, a little to the left of the middle line, you can feel the beating of the heart. The heart works like a force pump, and the beating is evidence of the work it does in forcing the blood through the body. The beating of the heart forces the blood to flow from a wound or cut.

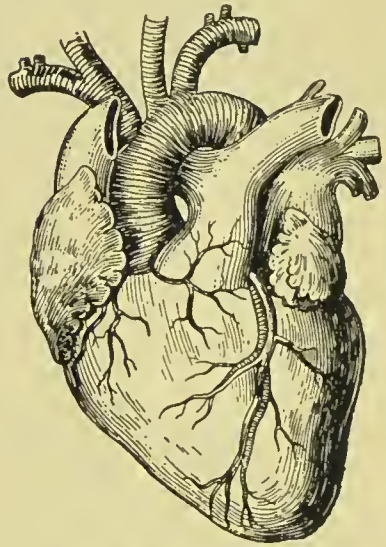


FIG. 29.—The Heart.

The heart is in the chest, between the lungs. It is a pump and is composed of muscle. It is shaped like a strawberry. Would you like to know its size? Close your hand and look at your fist; this is about the size of your heart. But why are not candy hearts and the pictures of hearts on valentines shaped like a strawberry? On the heart, near the top, there is a shallow groove filled with fat. This

yellow fat forms a notch in the outline of the red flesh or muscle. The first pictures of the heart were drawn to show only the red part of its surface. Thus the custom arose.

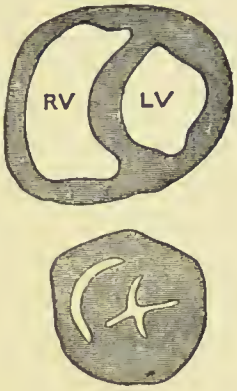


FIG. 30. — These figures show the relative sizes of the ventricles of a dog's heart contracted and expanded.

Lay the forefinger lightly upon the cheek, just in front of the ear, and feel the throbbing of **the pulse.** The throbbing may be felt also in the neck, and in the wrist back of the thumb. One beat of the heart occurs before each pulse. Since the heart is a pump, it forces on the blood at each stroke. You have noticed similar action while pumping water. This pumping of the heart makes the pulse which you feel. The blood is not held in the body like water in a sponge, but it is in tubes called blood vessels. Blood vessels are found in every part of the body. The tubes which carry the blood from the heart are called **arteries**; the tubes which bring it back are called **veins.** The very small blood vessels which carry the blood from the arteries to the veins are called **capillaries.** The capillaries are very tiny tubes which, by connecting the arteries with the veins, enable the blood to circulate through the body. Wherever you stick a pin into the skin, you reach

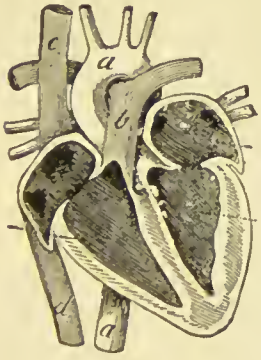


FIG. 31. — Diagram of the Heart, showing its Chambers and Blood Vessels.

one of these tiny tubes. Notice how the blood flows when you prick the skin with a pin. Blushing is caused by the filling up of the capillaries.

The blood has many important functions. On its way through the lungs the blood receives oxygen from the air in the air cells, and gives up carbon dioxid. In the digestive organs it takes up food. It carries oxygen and food to all the organs and tissues, each taking what is needed. From all the organs and tissues it carries the carbon dioxid and other waste substances. Through the lungs and kidneys and skin, it passes off waste material. Lastly, the blood, as it circulates, distributes to all parts of the body the heat produced by the activity of the muscles and glands. Of these two kinds of organs you will learn more later. Briefly, it may be said that the blood has two functions: to take nourishment to all parts of the body and to take away the waste material.

FIG. 32. — Diagram of a Network of Capillaries. *A*, artery, *B*, vein.

The appearance of the blood under the microscope differs from its appearance when seen with the unaided eye. You have all seen blood and know that it is red and thicker than water. Under the microscope it does not appear to be a red liquid at all, but a watery looking fluid, with many little white and colored corpuscles floating in it. The

blood appears red, just as water in a pan, with many red cranberries or strawberries floating in it, looks red.

The parts of the blood are really three in number. First, there is the thin watery part composed of water and of the food which is eaten. The nutritious parts of the food are taken up by the capillaries in the walls of the stomach and intestines, and carried into the veins.

FIG. 33. — The General Distribution of the Blood Vessels.

Second, there are the corpuscles, so thin and round, known as the red corpuscles. Although looking at them singly, under the microscope, they are yellowish in color, they appear red when many are seen together. Each one of them carries a load of oxygen gas from the lungs to the organs, as boats carry coal down the river. The corpuscles lose their bright color when they give up their oxygen to the brain and other organs. The blood now appears dark and purplish in color until the corpuscles get another load of oxygen in the lungs.

Lastly, there are the white corpuscles, which are like policemen. They arrest any harmful germs or particles that get into the blood. Instead of putting them into jail, they devour and thus destroy them. The white corpuscles are much larger than the red ones, though the red ones far exceed the white ones in number. If a splinter gets into the skin a number of white corpuscles gather around the splinter and keep it from doing further injury to the body. After a while they cause the place to fester, and succeed in pushing the splinter out. Perhaps you have noticed a whitish appearance around a splinter or sore.

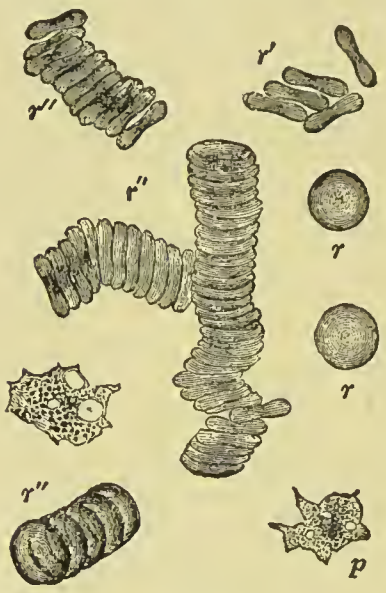


FIG. 34. — Blood Corpuscles as seen under a Microscope.

r, red corpuscles, lying flat; *r'*, red corpuscles, on edge; *r''*, red corpuscles, gathered in rows; *p* and *g*, white corpuscles.

It has been stated that the heart pumps the blood in **two directions** ; from the heart to all parts of the body, and from the heart to the lungs to be purified. One pump cannot send two streams of water in different directions. The heart really is a double pump. The left side of the heart is one pump, moving pure blood; the right side is another pump, moving the impure blood. Each pump has two chambers. (This makes how many chambers all together in the heart?) The upper chambers of the

pump are called auricles; they receive the blood. The blood passes from the upper chambers to the lower chambers, which are called ventricles. The latter force the blood out of the heart.

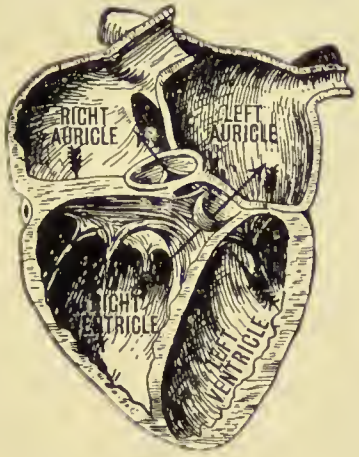


FIG. 35. — The Chambers and Valves of the Heart.

You are now prepared to give a complete account of the **circulation of the blood**, starting at some point in its course, and naming the organs in order through which it passes until it reaches the same point again. Let us begin with the impure blood as it enters the heart, coming from the body through two large veins, and entering the right auricle. The auricle contracts (remember that the heart is a hollow muscle) and sends the blood into the right ventricle below it. Next, the right ventricle contracts; at the same time a valve composed of three flaps closes up against the opening between the right auricle and the right ventricle, so that the blood cannot go back into the auricle, but is sent through the pulmonary artery to the lungs. After passing through the capillaries of the lungs and exchanging carbon dioxid for oxygen, the blood comes back to the heart by four veins and enters the left auricle. By the contraction of the auricle it goes into the left ventricle, passing through a valve of two flaps. The ventricle contracts, the flaps of the valve being

closed against the opening between the auricle and ventricle by the blood which would otherwise rush back to the auricle, and forces the blood out through one large artery, which soon subdivides into smaller ones. The smaller arteries carry the blood to all parts of the body. It passes through the various organs in very small tubes, much smaller than a hair, called capillaries. Through the thin-walled capillaries the blood gives to each organ the special substances needed for its particular work (like an expressman delivering packages in a city). It takes up carbon dioxid and other waste materials. The capillaries then unite to form tiny veins. These unite to form larger ones, till at last they form two great veins which bring the blood back to the right auricle again. Thus you see why the movement of the blood is called its circulation; it goes over the same path again and again, making a circuit each time, as if it were going around in a circle.

STORY OF A BLOOD CELL, OR THE FAIRY'S BOAT RIDE

Did you ever hear of a fairy? One evening after a teacher went home from school, he fell half asleep and a very strange story came into his mind. He imagined he was a little fairy that lived under the water and went riding in a little red boat called a blood cell.

The boat was floating in a stream, called the blood, which flowed in the body of a boy who was not very large, though he seemed a giant to the

little water fairy. There were thousands of other tiny red boats in every small drop, so that the blood appeared red. The boat floated on until it came to the stomach, through the walls of which food, made from the eggs, bread, and milk the boy had eaten for breakfast, came into the stream. The boats went floating on, and came to a large place with four rooms, called the heart. So many came in that the heart was soon filled.

The fairy had been wondering what caused the stream on which this boat was floating without rowing to flow so fast. He now found out, for the heart gave the boats a hard squeeze, and sent them in a great hurry to the lungs. It was a delightful place in the lungs. The air the boy was breathing took away the impurities of the blood and gave a load of oxygen. The cells, which had been dark red, at once became bright red, and his boat, or cell, looked as strong and good as new. After the boat passed through the small tubes of the lungs it floated back to the left side of the heart.

The heart again gave a hard squeeze, and sent the boats out with a merry bound through a big blood-tube called an artery. This tube soon branched into two, and the fairy's boat whirled (for it was as round as a tub) into the branch going toward the boy's feet. As it went toward the surface of his body, it came to a wonderful maze, or tangle of winding passages. These passages, or capillaries, were all very small; the little fairy thought his boat would never get through. The boats moved very slowly,

one after another. The bones and the muscles and the skin were very hungry and unloaded the boats of their cargoes of food and oxygen, and loaded them down with carbon dioxid and other impurities. At first the muscles were weak because they were loaded down with waste matter; now they became strong and active again. The fairy saw some boats lodged in the tiny tubes, looking very dark, for the boy had been lazy and his muscles did not move enough to help the heart push all the boats along. Every time the heart beat, the boat received a little shove. It got through at last and came out into a loose, baggy pipe called a vein. It floated slowly back, first to the right side of the heart, then to the lungs, to exchange its load of waste matter for oxygen, then to the left side of the heart. When it left the heart again it took the fairy through a tube leading to the brain. The brain was busy thinking and studying. The oxygen which the boats brought made the boy's mind active, so that he could learn his lessons readily. As the boats were going back through his cheek, a big mosquito drew this fairy boat and many others into his long sucking tube. The boy slapped the mosquito and broke his sucking tube. The little fairy escaped, but he never heard what became of his poor boat.

Be ready to write, or to tell your teacher, the story. Tell where the fairy boat went, and what happened to it in the stomach, lungs, heart, maze of winding channels, and brain.

CHAPTER VI

HYGIENE OF THE CIRCULATION

Does your face ever flush, even though you are not blushing, or sitting by a fire? When you are older and study an advanced book in physiology, you will find out how muscular exercise affects the circulation. The glow and warmth resulting from active play and work are more beneficial to the body than the warmth which comes from a fire. The heart is stimulated by exercise.

People who sit at their work all day long find that their circulation becomes sluggish because the brain and other organs do not get enough pure blood. Such people feel dull, lose their appetites, and become low spirited. Some of them take alcohol or other drugs to stimulate the circulation. What they really need is to take exercise. This makes deep breathing necessary and causes the heart to beat more rapidly. It does this without poisoning the body by alcohol and other drugs. Boys should not run, or girls jump the rope, long enough to injure the heart by making it do too much work. By running or exercising a little longer each day, the heart becomes so strong that it does not readily begin to thump when much effort is put forth.

A very cool bath, followed by vigorous rubbing

promotes the circulation better than poisonous stimulants.

It is more dangerous to cut an artery than a vein. This is because the walls of the veins are thin and flabby, so that when cut they have a tendency to fall together and close the opening. There is little danger from a cut vein unless it be one of the large veins of the neck, armpit, or thigh. On the contrary, the walls of the arteries are stiff and tough and do not readily close up, even if pinched together. The cut end often has to be tied to keep it closed.

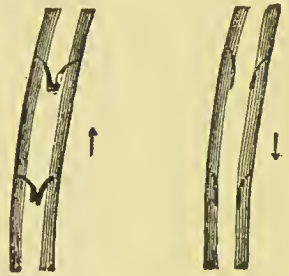


FIG. 36. — Showing the Valves in the Veins open to allow blood to go to the heart and closed to prevent a backward flow.

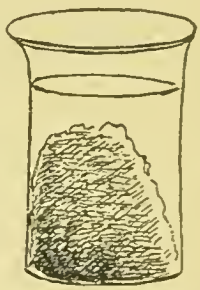


FIG. 37. — Showing How the Blood Clots after it coagulates. The clot is shrunken and floating in the watery part.

The heart is pumping blood into the arteries at every contraction. This action forces the blood out of a cut artery in jets rather than in a steady stream.

If the blood comes in a slow, steady stream, we may know that a vein has been cut; if it comes in jets, an artery. Why is there this difference? What makes the pulse beat? Why is there no pulse in the veins? Which do you think should pass along close to the bones, deep below the surface — your veins or your arteries? Why? The arteries are the ones that are so located and they are therefore less likely to be injured than the veins.

Bleeding from a severe wound may be stopped by tying around the limb close to the wound a handkerchief, towel, or anything at hand suitable for a bandage. Put a stick under the bandage, twisting it round and round, so as to hold the bandage tight and cause the knot to press upon the blood vessel. If an artery has been cut, the pressure must be applied on the artery between the wound and the heart. Why? If a vein has been cut, the pressure must be applied on the side of the wound away from the heart. Give the reasons for this, remembering that the blood flows from the heart to the arteries, from the arteries to the capillaries, from the capillaries to veins, and from the veins to the heart.

When blood is exposed to the air, it thickens or coagulates, and the coagulated blood, by filling up the cut, stops the flow. The thickening is caused by little strings that form in the watery portion of the blood and entangle the corpuscles. Blood thickens more quickly if the cut is bathed in hot water; bathing the cut in cold water retards the thickening.

The heart like the other muscles must rest; it does rest after each beat. These many little pauses or rests amount to about eight or nine hours during twenty-four hours. You breathe about twenty times in a minute, and your heart beats about four times as fast as you breathe,—about eighty times a minute. The hearts of grown persons do not beat so rapidly.

A Boy with Presence of Mind. — Mrs. Barnett gives the following account of a brave boy who saved his sister's life by using his wits and the little physiology that he had learned:

The boy was about twelve and his sister some three years younger. They were out playing in a hayfield. The sun shone, the sky was blue, and soft fleecy clouds floated overhead.

While the haymakers went to eat their dinner under the shady hedge at the other end of the sixteen-acre field, the boy took up the scythe to try his hand at mowing. Two or three strokes went well, but at the fourth effort the scythe slipped over the grass instead of through it, and Mary having come too near in her eagerness to watch his prowess, received the stroke of the sharp instrument on her leg, just above the ankle.

In a moment she fell with a scream, the blood pouring out all over boot, stocking, and frock as she lay on the ground.

What would you have done? Run screaming across the hot field to fetch the haymakers? If you had, Mary would have been dead before you came back. This her brother knew.

"Don't scream, Mary," he said. "It will be all right."

Fortunately he remembered about the blood in the arteries being red and that in the veins being blue, or dull purple red.

Mary's was red; there was no doubt of that; red as red could be, as it came out in little jerks and made almost a puddle by its quantity.

Off came Jim's necktie and round the leg he bound it, near the wound, but on the heart side of it. Being a boy, he could tie a knot, and so the necktie was tied tight, and the blood stopped flowing, and Mary was saved. Then he hallooed and shouted till the haymakers heard and came and carried the child home, where she lay in bed till the parts that had been cut — the muscles and the artery — had joined together again, and in the meantime the blood had to go by other ways and use more and other capillaries to take it back to the veins.

Everybody was pleased with Jim for saving Mary's life, and Jim himself was not a little proud, I can tell you, though sometimes he gave his teacher credit for teaching him what to do.

Effect of Alcohol upon the Heart. — The nervous system controls the heart. There are two sets of nerves which exercise this control; one set of nerves increases the heart beats and the other decreases them. If the heart beats either too rapidly or too slowly, it can be regulated. The nerves that diminish the heart action may be compared to the balance wheel of a watch which keeps the spring from "running down" all at once. They may be compared also to the brake on the wheel of a wagon. Disconnect the balance wheel and the watch ticks wonderfully fast for a time; if the brake is taken off, the wagon dashes down the hill at a rapid rate. Alcohol affects the heart by acting chiefly upon this last set of nerves which serve as a "brake." When these nerves are deadened, the heart beats more rapidly.

Hence, the so-called stimulating effect of alcohol is really a deadening effect upon the nerves. A narcotic is something that deadens the nerves or stupefies the brain. Alcohol is therefore called a narcotic. The rapid beating of the heart shortens the rests

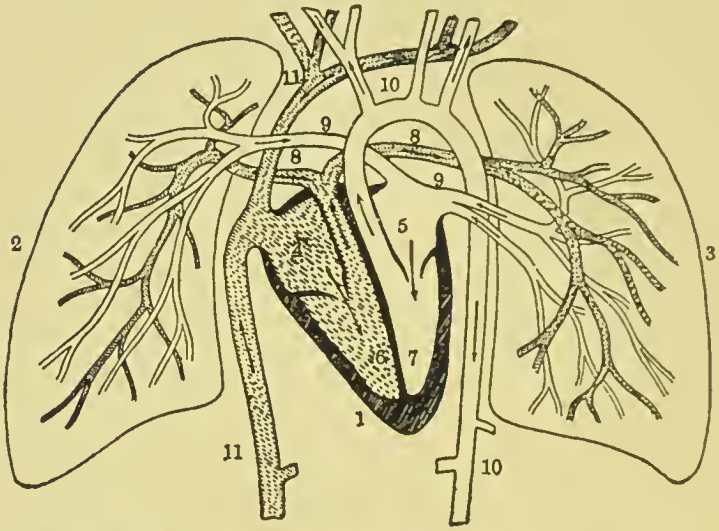


FIG. 38. — The Circulation through the Heart and Lungs. The shading denotes impure blood. Begin at 11 with the blood coming from the body and follow the arrows with a pencil and see whether the pencil comes out at 10. The blood will have gone twice through the heart and once through the lungs, and at 10 is returning to the body.

and tends to weaken the organ, frequently resulting in a diseased condition. Although stimulating and injuring his heart by drinking alcohol, the drinker gains no advantage in the end. The heart soon becomes tired and beats more feebly than before the alcohol was drunk.

Alcohol and the Blood Vessels. — There are nerves in the walls of the veins and arteries which cause them to expand or contract just enough to keep

the necessary amount of blood flowing through them. But if one drinks beer, wine, cider, brandy, whisky, or any other alcoholic drink, these nerves are at once deadened and allow the vessels to expand more than they should. The flushed face, or the red, blotched nose of the drinker, shows the effect of this deadening of the nerves.

Effects of Alcohol upon the Blood. — Alcohol injures the red corpuscles of the blood. Why does this affect the supply of oxygen in the body? Alcohol also injures the white corpuscles and lessens their power of protection against disease germs. In the South, where the dreadful disease of yellow fever formerly raged, drunkards were among the first to be attacked and among the first to die. The experience has been similar in the case of other contagious diseases.

The "Tobacco Heart." — Tobacco also is a narcotic. The beat of the heart is quickened, but the strength of the beat is lessened. Excessive smokers are often afflicted by severe pains in the region of the heart. The tobacco heart, from which tobacco users often suffer, is caused by the irregular action of the heart (beating either too rapidly or too slowly). Have you ever noticed how your heart thumps when you are startled? This thumping is called palpitation. The "tobacco heart" is either palpitating or beating too feebly. Many volunteers wishing to join the army in the late war with Spain were rejected because they were suffering from the "tobacco heart."

Review Question. — Why does the effect of alcohol upon the heart resemble the effect of removing the brake from a wagon, not that of adding strength to the horses.

Thought Questions. — Does Alcohol make the Body Cold? — What color has the face of a man who has just been drinking? What are the effects of alcohol upon the nerves which control the muscular walls of the blood vessels? Can you explain why alcohol makes one red in the face? Does this reddening of the skin make one feel warm or cold? Why does blushing cause your face to feel warm? Do the nerves of feeling end near the surface or deep in the body? When you feel warm or cold, what part of the body is really warm or cold?

Where does the warm blood come from that warms the surface? Is it warmer or colder when it gets back to the heart? Why must you wrap up a hot iron or brick when you wish it to remain hot? Why then is the blood cooler when it leaves the surface? How do some people use a spoon in order to cool hot soup? Does alcohol cause all the blood to become cool at once, or a little at a time, as in cooling the soup? What parts of the body are chilled by the cool blood that leaves the skin? Is it more important to have a warm skin or a warm heart? How does alcohol deceive the drunkard about the temperature of his body?

Alcohol also makes him think he is strong when he is weak, wise when he is foolish, rich when he is poor. What does the Bible say of wine? What does

it say of the man who is deceived by strong drink? Is it true that alcohol "warms up the inner man"?

Give a connected account, either orally or in writing, as your teacher may direct, of "How Alcohol makes the Body Cold." The lumbermen of Maine, and others whose business takes them out in the severe winter weather, have learned that people who drink whisky to keep warm freeze to death more quickly than those who abstain from drinking.

"Nowhere is it so cold as in the Arctic regions. A while back a brave set of men offered to go and try to find Sir John Franklin, who was, alas! lost amid those vast lonely ice-fields. The ship was built and packed, and a plentiful supply of whisky, gin, and brandy was put in for the men's use; and all safely reached the land of ice and snow, and soon began their search. A 'nightcap,' as they called it, was served out to each one as he was huddled up in the skin bag that served for his bed and blankets, and then the last man out took an extra strong dose himself, and joined the others; and they were only too glad when morning came if they found no one's ear ready to drop off or his nose dead because circulation had stopped and the frost had bitten it.

"If ever it was cold, it was there; if ever grog could 'keep the cold out,' then was its chance.

"Once a little band of the sailors tried to get across a great ice-field to see if something they saw by the field-glass was either the lost ship or the huts of the men they had come to find. It was very rough, hard walking, and the grog-barrel had to be

left behind. What grumbles there were at no 'nightcaps'! What fears that they should be frozen without the grog to keep the cold out! But when morning came one man after another confessed to his fellows that he had been warmer than usual that night.

"The news spread; other men tried to do without the 'nightcap,' with the result that at last nearly all refused it, finding it useless.

"I could tell you other stories about beer, and how the soldiers marching in the sweltering heat of Afghanistan found no strength in beer, and left it all behind in the desert." — MRS. BARNETT.

Clothes and the Circulation. — Which are more interfered with by pressure, the veins or the arteries? Which are situated nearer the surface. The veins, you will remember, have thin walls and are not directly affected by the beating of the heart. Tight garters often cause cold feet. Bands around the waist tight enough to support skirts interfere with the return of the blood to the heart from the lower part of the body. Tight collars or other tight clothing around the neck, may cause weak eyes, a dizzy feeling, headaches, and frequent colds. Even a tight shoe may interfere with the circulation and add to the work of the heart.

How all the Organs depend upon the Blood. — If you realize how the work of every organ in the body depends upon the heart, you will be careful not to weaken it or add to its load by wearing tight clothing, by neglect of exercise, or by doing anything else that will injure it.

Unless the brain is supplied with pure blood, the mind lacks clearness and cannot do its work well. The chest must be sufficiently expanded to allow the blood to circulate through the lungs freely and

FIG. 39. — Men of the Life-saving Service at work on the shore. Do you see the lifeboat? The storm is too great for it to be used. Do you see the cannon? The men are shooting a ball to which is attached a cord. The people on the ship will draw over the rope that is on the spool and come to shore in a basket. Suppose the Life-saving crew had shot down the flag of distress on the mast and said all was well; that is the way people do who take headache medicines, cough medicines, etc., to stop the pain.

to secure an abundance of fresh air, so that the blood may be enriched with oxygen and the waste matter carried out.

Every part of the body is unfavorably affected by impure blood. To do its work well and remain in a healthful condition, each organ must be supplied with pure blood. If the muscles are not properly

nourished, they soon become fatigued and work is performed with difficulty.

The stomach needs blood to aid in digesting the food. Unless the skin is properly supplied, it loses its healthful color and becomes pale, or dark and dingy. Even the strength and soundness of bone depend on the kind of blood supplied to it.

One house may be made of several kinds of material, such as wood, iron, and brick; the body is made up of several structures called tissues, such as bony tissue, fatty tissue, muscular tissue. The blood feeds all the tissues.

REVIEW LESSON. (*Health of the Lungs.*) — What is the effect of alcohol upon the walls of the air cells? Upon the blood vessels in the lungs? What does the word "inhale" mean? Why is it difficult to inhale smoke from a cigar or pipe? Why is it easy to inhale smoke from cigarettes? Give two reasons why strong cigar smoke in the mouth does far less harm than weak cigarette smoke in the lungs. How are smokers sometimes disagreeable to other people? What three things does the burning of the food by the oxygen accomplish for the body? What do plants take in through their leaves? What do they give out? What is the effect of dust upon the lungs? Why are people who live in dusty houses often pale and unhealthy? How long does it take the air of a closed schoolroom to become impure? What is the easiest way to prevent drafts? What is said in regard to the height to which windows may be raised? Give an account of the Black Hole of Calcutta. What two qualities in the air of a room must be provided for? Should the stove be placed near a window or by the wall opposite the windows? Why? Why should the warm air not be allowed to go out at the top of the window nearest the stove? What is the effect of good ventilation upon sleep? Tell the story of "The Architect and his Two Friends."

CHAPTER VII

FOOD

Review Questions. — What is the element in the air that we take into our bodies through the lungs? What does this element do in the different organs? What gas is thus formed? How does the body get rid of this gas? What is chest expansion? Waist expansion?

The Alimentary Canal. — We take air into the body through the lungs, but we take all solid and liquid **food** through the mouth, which is the beginning of the alimentary, or nourishing, canal. This canal is a tube nearly thirty feet long in grown persons, but it is folded in such a way that it takes up very little room.

The food builds up and repairs the body, and by burning keeps the body warm and enables it to move. Thus the food serves several purposes. Since the muscles and other organs differ from the food which is to nourish them, it must undergo a change before it can be used by the body. Food cannot pass through the walls of the alimentary canal in the condition in which it is when eaten. Digestion is the change which the food undergoes in the alimentary canal. After food is digested it can pass through the walls of

the canal and can be dissolved by the blood just as sugar or salt are dissolved by water.

Oxidation. — You learned that oxidation in the body and the burning of a candle alike take place by the union of two things. What are they? Which of the two things in the body corresponds to the tallow of the candle?

FIG. 40. — The Sugar-cane supplies great quantities of sugar.

Of two horses eating the same quantity of food, which is more likely to be fat, the idle horse or the horse that works hard? Do you have a better appetite when you work and play or when you do nothing? Which are more likely to have good appetites, boys or girls? Why? The facts suggested by these questions go to show that food enables us to do work. If we do not breathe pure air, food does us but little good. Explain why. Pure air contains oxygen. How does oxygen enable us to work?

Oxidation is always accompanied by heat; the oxidation of the food in the body gives rise to the heat which keeps the body warm *Sugars*, starches, and fats are the foods which give most heat and power. They are also stored up in the body as fat.

Tissue Making. — The stove furnishes a means for the oxidation, or burning, of wood, the lamp wick

for the oxidation of oil, and the tissues for the oxidation of food. The tissues, like the lamp wick, are oxidized slowly and have to be repaired. Certain of the foods that we eat are used by the tissues in repairing themselves. They are called the flesh-forming, or tissue-making, foods. All foods of this kind contain a substance called **proteid** (prō′tē-id). The albumen, or white, of an egg is an example of a proteid.

You may have heard that the body is entirely renewed every seven years. Very active parts, like the heart, are probably renewed in two or three months, but the less active organs, such as the bones, require a longer time.

Food also enables the brain and nerves to act, hence it enables us to think. Now name all the uses of food that have been mentioned.

Foods that are chiefly Tissue builders (Proteids)	Foods that are chiefly Fat and Heat Givers (Fat, Starch, Sugar)	Foods belonging to both Classes
cheese	butter and cream	milk
white of egg	fat meat, lard	eggs
lean meat	honey, sugar	meat
the gluten or sticky part of flour and meal	starch of flour and meal,	chestnuts
beans	corn, rice	pecans and other nuts
peas	cottonseed oil	fruits
	olive oil	
	potatoes, turnips	

Some foods contain very little nourishment, being made mostly of water and woody fiber, as green

vegetables. Fruits contain much water, but not much woody fiber. Water and salt are important foods; they are not placed in either column, as they enable us to use the heat-giving and tissue-building foods. In which column would you put tobacco? Some persons chew tobacco. Why do they not swallow it? What is the difference between a fat person and a fleshy person? Which of the two has the greater strength? Name two foods of which we may eat freely in summer; less freely. Name two foods of which we may eat freely in winter. Are hearty eaters or light eaters more likely to suffer from heat in summer?

FIG. 41. — Olive Branch and Fruit. Olives and nuts supply nutritious oils. The olive is nearly black when ripe. Green olives are of no value as food.

An Eskimo boy prefers a tallow candle to cheese. Explain why.

Meat is a nourishing food, but if more than a proper proportion is eaten, the albumin forms a substance which tends to make one cross and irritable.

Fats give more heat than starch or sugar. The best kind of fat to eat is in foods that are not cooked, as butter, olive oil, and oily nuts. Hickory nuts, butternuts, pecans, and walnuts are oily nuts. They

should not be eaten early in the autumn as they may not then be perfectly ripe. They should be thoroughly chewed.

Cottonseed oil mixed with lard is used in cooking. This oil is shipped to Europe, refined, and sold as olive oil. Much of it comes back to America under that name.

Many things which we eat contain several kinds of food. Wheat flour contains starch, sugar, and proteid called gluten. Peas and beans are rich in starch, and contain more tissue-making food than any of the grains. Irish potatoes contain starch; they are more than two thirds water. Corn contains starch, gluten, and oil. Yellow corn has more iron than white corn. Lime and phosphorus are also found in grains: with gluten they help to make bones and teeth. Hence the whitest flour, which is mostly starch, is not so good as the flour which contains all the elements found in the grain. What kinds of food are contained in milk? In eggs? Eggs do not contain so much of heat-giving food as of tissue-making food. The former is not needed, for the hen keeps the unhatched chick warm with her own body. Hence the yolk is smaller than the white of the egg.

FIG. 42. — Wheat supplies more food than any other grain except rice. It contains much proteid.

Water is the most necessary of all foods. Many nations use no other drink. Nearly three fourths of the body is water. Fruits and vegetables contain much water. Besides the water we get in our food we should form the habit of drinking freely

FIG. 43. — Rice in the Hull.

Rice feeds more people than any other grain. It is chiefly starch. In what countries is it the chief food supply? In those countries the people eat peas or beans or cheese or nuts to supply the proteid which is lacking in rice.

every day good, pure, cool water. Dr. Tanner lived forty days, almost six weeks, without taking any food or drink other than water. If he had done without water also, he would probably not have lived a week.

Sometimes tired and thirsty people drink glass after glass of ice water. Such recklessness may

lead to congestion of the blood in certain organs and result fatally. Ice water does not quench thirst like cool water. Drinking much of it makes one thirsty. If you cannot get any water to drink except ice water, either sip it very slowly or wait until it is cool instead of cold.

Besides common salt, which is found in the earth, other salts are needed as food. We cannot digest them in their mineral form, but they are found in fruits and green vegetables. In this form they are digestible. The salts of iron and phosphorus are the most important of these. It is iron that gives the red color to the blood; it gives the red color to tomatoes also, and the brown color to wheat and other grains.

Besides the salts, green vegetables contain very little nourishment for man. They resemble grass. Such substances are very useful as food for cattle; with them digestion is a slower process than with man. Cows and sheep have four stomachs and can digest grass.

How many of the girls in the class are learning to cook? They should begin with the easier dishes. If a girl wishes to learn music, she should begin with an easy instrument like the guitar. If she cannot learn to play it, she will know that she cannot learn the piano. But many a girl who is making a failure with music could become expert in cooking. Good cooking keeps half the food from being wasted, saves half the doctor's bills, and doubles the happiness of the home.

THE FOX WITHOUT A TAIL

A fox was once caught by the tail in a trap. He knew that he would be killed if the hunters found him there. So he managed to get away, leaving his tail in the trap.

He felt very much ashamed to be without a tail, and tried to keep from meeting any of his friends. He was afraid they would laugh at him.

After a while he called his friends together and talked to them about it.

"You really can't think," said he, "what a nice time I have without a tail. Tails are so much in the way. I can get about much more easily since I lost mine.

"I am sure you would all look a great deal better and be much happier, if you would have your tails cut off."

"If you think so," said an old fox, "why didn't you have your tail cut off before? I think you would be very glad to get it back again if you could. You want us to have our tails cut off only that we may look as bad as you."

Once there was a boy who learned to smoke. He began by using cigarettes which are about half as big as your little finger. They are so weak that a boy who is hardly more than a baby could smoke one by drawing the smoke into his mouth and it would not make him sick.

Very soon this boy learned to smoke a number of cigarettes each day and to *draw the smoke into his*

lungs. This made him weak and he became a slave to cigarettes. Everybody lost respect for him. He did not grow so fast as the other boys and was not so sound and strong. He could not study and keep up with his class.

He was afraid the other boys would laugh at him, so he said to them, "You really can't think what a nice time I have with cigarettes. They are not at all in the way, and I am sure you would look better and be much happier if you learned to smoke them." But one of the boys said, "You only want us to smoke cigarettes so that we will not get along any better than you do."

REVIEW LESSON. (*Health of the Circulation,* Chap. VI.)—What is the effect of exercise and work (1) upon the breathing, (2) upon the heart? Why is exercise a better stimulant than drugs or alcohol? How may the heart be made stronger gradually? Why does a cold bath stimulate in a better way than alcohol? Why is it more dangerous to cut an artery than a vein? Which is most exposed to danger? How may we know whether a vein or an artery has been cut? How may bleeding be stopped? Where should the pressure be applied if an artery is cut? If a vein is cut? What is coagulation? About how much does the heart rest in a day? What is the rate (1) of breathing, (2) of the pulse?

Tell the story of the boy that cut his sister's ankle. Explain how alcohol makes the heart beat faster. What is a narcotic? What proves that alcohol is a narcotic? How does alcohol cause the face of the drinker to become flushed? How does alcohol cause heat to leave the body? How does alcohol make the body more liable to disease?

CHAPTER VIII

DIGESTION

Review Questions. — At what temperature is the body kept? What furnishes the heat that keeps it warm? What are the two functions of the blood? How does alcohol make the body cold? What is the length of the alimentary canal? Why is it necessary for food to be digested before it can become tissue? Of what does the change called digestion consist?

The Teeth. — In order that the digestive fluids may penetrate the food and make it soluble, it must first be ground very fine. Look at your teeth in a mirror. Use a hand mirror. (Have your back to the light so that the mirror may reflect the light into the mouth.) Also feel the teeth with the fingers. What is the shape of those in front? Of those in the rear part of the jaw? Which are suitable for **cutting**? Which for **grinding**? How many cutting teeth are there?

The Two Sets. — When a child is about six years old, the teeth of the first set, usually called the **milk teeth**, begin to drop out, and the second, or **permanent set**, takes their place. This set numbers thirty-two teeth and is not completed until the person is grown.

In the center of each tooth there is a hollow containing **pulp**, consisting chiefly of blood vessels and a nerve. Most of the substance of a tooth is made of **dentine**, something like bone. The part outside the gum is covered with a thin layer of **enamel**, a very hard, shiny substance composed of mineral.

Decay of the teeth results from fermentation of particles of food lodged between the teeth. In this

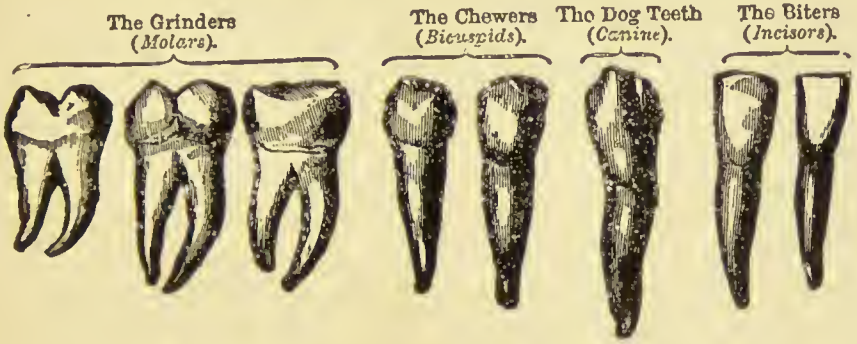


FIG. 44. — The Teeth Classified.

This figure shows the eight teeth in one half of the jaw. Hence, although there are but three molars, two bicuspids, one canine, and two incisors in the figure, there are actually four times as many of each in the whole set of teeth.

way an acid is formed. The acid dissolves the mineral matter of the teeth. This acid is readily formed from sugar. Perhaps you have heard some one say to a small child, "Let me look at your teeth; I want to see whether you bother your mother's sugar barrel." The excessive eating of sweet things at meals or eating sweets between meals is injurious to the teeth.

Many persons like to eat a dry crust after finishing a meal. If they stop eating with a sweet taste in the mouth, the mouth may become sour. If one cracks hard nuts with the teeth or chews rock candy,

the teeth are apt to slip, and in striking against one another the enamel is cracked.

Washing the teeth helps to preserve them. Wooden toothpicks are very useful, but the best way to keep the teeth healthy is to use them on food that is tough and hard enough to require good chewing. Some young people refuse to eat the crusts of bread, and bread that is tough, because it has not been "shortened" with lard. One would think they were old people without any teeth.

Cows and sheep are believed to have had upper front teeth a long time ago. By forming the habit of using the tongue instead of those teeth, when grazing, they have lost them through disuse. The upper jaw of a little calf has the beginnings of those teeth, but they disappear later on. Any gift that is not used is soon taken away. The fish in the waters of dark caves lose their eyes and become blind. The mole has almost lost its eyes because it uses them so little. In order to preserve the teeth, we should eat food that needs chewing and we should chew it well.

There is another reason for chewing the food well. By chewing, the saliva is thoroughly mixed with the food. If you chew some grains of wheat, a cracker, or some bread, for a long time, you notice that it acquires a sweet taste. This is because part of the starch in the food has been turned to sugar by the saliva. Thus one important step of digestion is performed in the mouth. The proteids and fats are not acted upon by the saliva.

Fear, anxiety, and other strong feelings prevent

the flow of saliva. In India people suspected of thieving are sometimes made to chew rice. If the rice remains dry, the man is deemed guilty.

The saliva is secreted, or formed, by six organs called salivary glands. The saliva should never be wasted by useless spitting, such as smoking or chewing tobacco induces. Chewing-gum, unlike tobacco, contains no poison; the saliva arising from the use of the gum is usually swallowed. This irritates the stomach. Nevertheless, chewing gum is not nearly so injurious as chewing tobacco.

FIG. 45. — Salivary Gland, drawn slightly enlarged to show the many little sacs opening into the ducts. This gland is in the cheek. It swells in a disease called mumps.

The gullet is a fleshy tube leading from the throat to the stomach. You can feel the gristly windpipe in the front of the neck. The gullet is behind the windpipe, hence the food has to pass the upper end of the windpipe to enter the gullet. The windpipe has a lid that covers it when we swallow. It would not do for food to enter the windpipe. (Fig. 22.) If you talk or laugh when there is food in the mouth, the food may be sucked into the windpipe before the

lid can close. Sometimes a slap on the back helps one who is choking to cough up the obstacle.

The stomach is a pear-shaped bag placed across the upper part of the abdomen just below the diaphragm. It is capable of holding about two quarts. The larger end is on the left side where the gullet enters; the smaller part is toward the right side and opens into the intestine. The stomach has two openings or mouths. Are both openings on top? (See Fig. 46.) Around the opening into the intestine is a band of muscle which regulates the size of the opening and the passage of the food.

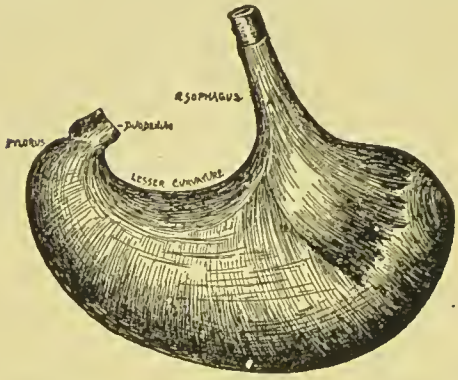


FIG. 46.—The Stomach, showing the direction of its Muscular Fibers.

The lining of the stomach is soft, like velvet, and contains many little glands which secrete a liquid called the gastric juice. Have you ever seen a piece of tripe at the meat market? This is the stomach of an ox or a sheep, and gives you an idea of the thickness of the wall of the human stomach. It also shows the velvety appearance of the lining. Outside of the soft lining there is a layer containing muscular fibers which contracts in such a way that the food is gently moved from one end of the stomach to the other. This movement mixes the food with the gastric juice.

Only one kind of food is digested in the stomach;

this is the proteid matter. Give examples of such food. Chyme is the name given to the food in the stomach, when, after two or three hours' digestion, it is reduced to a pulpy and almost fluid condition. Some of the food that is already digested is absorbed by the blood vessels in the walls of the stomach, but the greater part gradually passes into the intestine. In order to pass through the narrow opening into the intestine, it must be sufficiently softened, or the band of muscle called the pylorus (or gate keeper) will not allow it to pass. Could a carpenter make a gate which would open itself at the right time and allow certain people to pass yet stopping others?

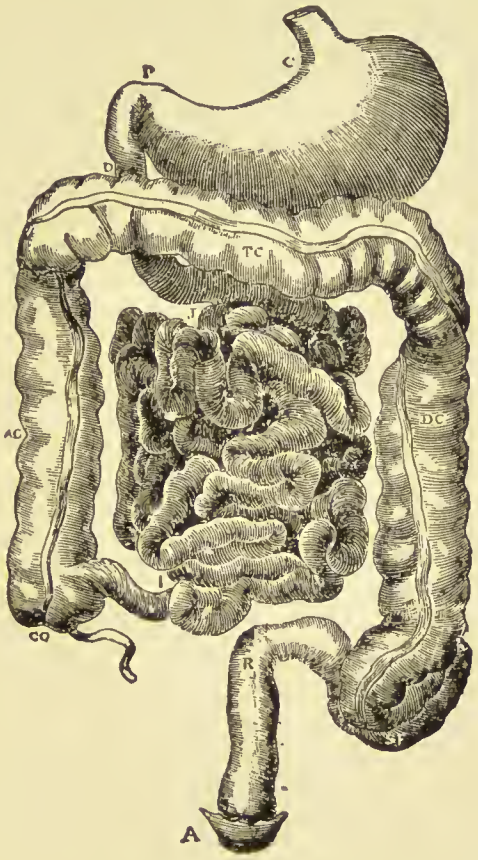


FIG. 47.—All of the Alimentary Canal except the mouth and gullet. Where does the stomach join the small intestine? Does the small intestine join the large intestine, or colon, on right or left side? The colon goes up, across, down, then has an S-shaped curve and a straight portion.

In the first part of the intestine the chyme mixes with two fluids, called the bile and pancreatic juice. The bile comes from the liver, and the pancreatic juice

comes from the **pancreas**, a long flat gland placed behind the stomach. The bile acts upon the fats, which withstand the action of both the saliva and gastric juice. The pancreatic juice is the most important of all the digestive fluids; this changes to sugar any starches that the saliva does not digest. It likewise acts upon the proteids which the gastric juice does not digest; and with the aid of the bile it act upon the fats. The pancreatic juice is the only fluid that acts upon three kinds of foods.

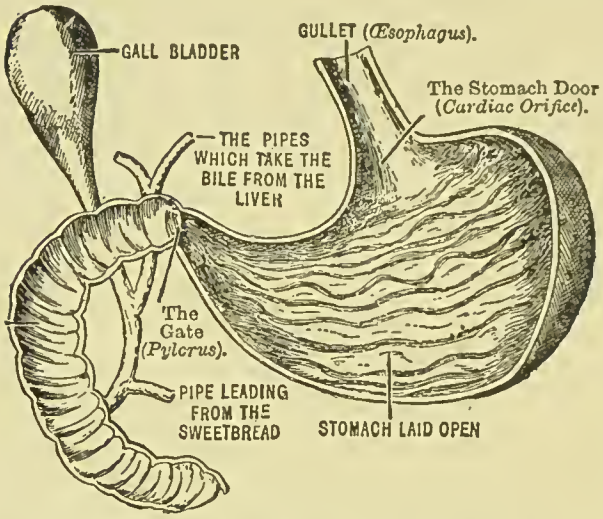


FIG. 48.—The Stomach and the Beginning of the Small Intestine, and their Connections.

The bile is secreted by the liver at all times; it is stored until needed in a little greenish bag, called the gall bladder. Thus a sufficient amount can be stored up ready for use. Some animals have no gall bladder; the horse is one of these. You may have noticed in the kitchen that the cook, when cleaning a fowl, is very careful not to burst the gall bladder. The bile is bitter, and if it were spilt upon the fowl, it would spoil the taste of the meat.

The **liver** not only produces bile to digest the

fats, but it is also a scavenger. It removes from the blood by burning some of the poisons of alcohol, coffee, tobacco, and drugs; thus it partly saves the other organs from being injured by them. Lastly, the liver is a storehouse, keeping in store a kind of sugar which is formed from starchy food. It gradually gives this sugar to the blood as the body has need for it. How many purposes are served by the liver? Name them.

You learned that the blood vessels take up most of the food when it has been absorbed from the alimentary canal. Thus the food is carried all over the body by the circulation. The blood always remains in the blood vessels, going the same round over and over again. The food, in order to get into the hungry tissues and feed them, must soak through the walls of the capillaries, thus leaving the circulation. The red corpuscles never go out into the tissues, but some of the watery portion of the blood, containing the food, passes through the walls into the tissues. After passing through the walls it is a colorless liquid called **lymph** (lĭmf). When the tissues have used as much food as they need, the colorless, watery lymph goes back to the blood in a very curious way. There are many little tubes, called **lymphatics** (lĭm-fat'ics), which begin with open ends in the tissues of the body. Every motion of the body serves to push some of the lymph into the open ends and to move it along the lymphatics. The lymphatics, unlike the blood vessels, have no heart to push the lymph along, but

it is moved forward by the pressure of muscles and by movements of the body. The small lymphatics unite with larger ones until the lymph is finally carried into two large lymphatics which empty the lymph into the blood near the neck. Thus waste of the food is prevented. Our bodies, like an economical housekeeper, allow no nourishment to be wasted. Lymph is seen in a blister.

The lymphatics called the lacteals have another use. The blood vessels themselves absorb all the food but the fats. The lacteals, which are the lymphatics around the small intestines, absorb the digested fat. The fats thus get into the blood in an indirect way. The lacteals empty into the large lymphatics, which, in turn, empty into the large veins near the neck, as stated before.

When the food enters the blood it becomes a part of the body. Up to this time it cannot be called a part of the body, although, in one sense, it is in the body.

The part of the food which is not absorbed by the blood is carried through the small intestine into the large intestine.

The glands which secrete the digestive fluids are affected by the mind as well as by the food. Nerves excite the glands to secrete when we taste, see smell, or even think of food. At the same time the nerves dilate the blood vessels in the glands, so that the glands may have plenty of blood with which to carry on their work. The food digests most readily if one when eating is in a cheerful, happy frame of

mind. An old Eastern story tells of a stranger who met the Plague coming from Bagdad. "You have been committing great havoc there," said the stranger, pointing to the city. "Not so great," replied the Plague; "I killed only one third of those who died; the other two thirds killed themselves with fright."

The glands of the digestive organs tire as well as the rest of the body; so do the muscles in the walls of these organs. The stomach and intestines should not be made to work all the time, or at all hours, or they will surely wear out. If good food is properly eaten at regular times, the stomach can do its work in two or three hours after each meal and have time to get rested before the next meal. If indigestible food is eaten, or if food is eaten between meals, the stomach does not get any rest. It cannot be expected to do its work well without rest.

Do you remember what the temperature of the body is? The stomach must be at the same temperature in order to work. Ice water is often not much above freezing point. If taken freely at meals or soon after, digestion stops until the temperature of the stomach is equal again to the bodily temperature. Such interruptions of the stomach's action are a fruitful source of indigestion. The person who eats ice cream very slowly is not only more polite, but also enjoys it more. Food digests more rapidly if eaten slowly.

If water is used at meals, it should never be taken while there is food in the mouth, because it

checks the flow of the saliva. Dry food is as necessary for the action of the salivary glands as hard food is for the health of the teeth. Soft, moist foods interfere with the flow of saliva. It is better to drink plenty of water between meals, as it may dilute, or weaken, the gastric juice if taken at meals. But persons who do not drink enough water at other times, find that health and digestion are aided by drinking at meals, because the body needs a certain amount of water.

Hot drinks, such as hot coffee, toughen the lining of the mouth, and may cause the gums to shrink back so as to expose the part of the teeth not covered with enamel and thus hasten their decay.

Are the requirements for healthy living burdensome or is life made more pleasant by meeting the requirements? Which has the greater pleasure, the one who bolts his food and gulps his drink, or the one who eats slowly and spends more time at his meals? Which enjoys the pleasures of the table the more, the one who eats regularly or the one who, like a chicken, is always ready to eat, and who, by munching candy and nuts between meals, destroys the appetite for meals? We enjoy the taste of food when we are hungry. If we eat when we are not hungry, we may be punished for it by having indigestion.

Some persons lose their appetites because their lives are not active enough; they do not work enough to burn up the food they eat. They are always put-

ting fuel into the furnace, but never have enough fire to burn it. So they lose appetite for good and simple food, but they are not willing to stop eating until the appetite returns. They put mustard, pepper, and other hot seasoning into the food to wake up the nerves, thus enabling themselves to eat food that they do not need. If a little pepper were to get into the eye, the eye would smart, become inflamed, and pour out tears to protect itself. The lining of the stomach also is delicate and easily inflamed. The hot seasoning put into the food causes mucus to flow to protect the stomach, but it does not increase the gastric juice or aid digestion. How can such people get honest and natural appetites? What kind of people usually have the best appetites? Sometimes, when the appetite is gone, kind friends attempt to awaken it by making broths and other delicacies. This is usually unwise, depriving the stomach of needed rest. How is it that living in overheated rooms or wearing too warm clothing decreases the appetite as much as lack of activity does.

We should not eat when we are very tired.

We should rest from work for half an hour after a meal or take only gentle exercise.

We should not eat heartily at supper. We should not eat between meals nor should we ever omit a meal unless we have no appetite. When the stomach is in the habit of digesting at a certain hour, the glands secrete the digestive fluid at the proper time. When food comes into the stomach

at an unexpected time, the juices do not flow so freely. The stomach works better when it contains a moderate amount of food than when it contains a very large or a very small amount. Both the glutton and the one who eats between meals make its work hard.

If you pour alcohol on the white of a raw egg, the white becomes hard. Alcohol also hardens lean meat and other proteid food. You learned that the work of the digestive organs is to soften and dissolve the food. Anything which hardens the food would interfere with the work of the stomach; but the lining of the stomach pours out a watery fluid as soon as alcohol is swallowed. This fluid keeps the alcohol from hardening the food and partly protects the tender lining, but digestion is slower and the stomach is weakened.

REVIEW LESSON. (*Sound Digestion.*) — Why does a person who chews tobacco not swallow it? Why is it important to drink much water? What is said of ice water? What gives the red color to the blood? Name food that contains iron. Why is it a great accomplishment to be a good cook? Tell the story of the Plague coming from Bagdad. Why should we not eat between meals? Show how ice water interferes with digestion. Discuss the drinking of water. Why are persons who lead inactive lives very fond of high seasoning? Why should they not use it? Give several rules for eating. What is the effect of alcohol upon proteid food before it is eaten? (The effect is not the same outside of the stomach and within it, as the stomach secretes mucus very rapidly when a strong drink is taken and thus dilutes it.)

CHAPTER IX

STIMULANTS AND NARCOTICS

Review Questions. — What effect upon growth do alcohol and tobacco have (Chapter I)? What effect upon the nerve cells of the drinker does alcohol have? Upon the nerve fibers? Upon his mind and character (Chapter II)? Why are cigarettes worse for the lungs than cigars (Chapter IV)? What is the result when people try to drown their sorrow by drinking alcohol? Explain how the so-called stimulating effect of alcohol upon the heart is really a narcotic or deadening effect (Chapter VI). Is the rapid beating of the heart any gain in energy to the drinker in the end? What kind of food is made indigestible by alcohol (Chapter VIII)? Is a stimulant something that takes strength out of a man or something that puts strength into him? What two things unite to form carbon dioxid? How is carbon dioxid gas formed in a fire? How is carbon dioxid gas formed in the body?

Foods that Spoil. — You know that there are many foods which do not keep fresh and pure. They spoil in a short time and become unsuited for food. Milk becomes sour, butter becomes rancid, meat decomposes. In this chapter you are to learn

about the spoiling of sugar and of foods that contain sugar. You may have noticed that sweet preserves sometimes spoil, or "work," as your mother calls the change, and bubbles of gas form at the top of the glass jar. This gas is carbon dioxid, about which you have already studied. One other substance is formed by the spoiling of the sugar; it is the poisonous liquid, alcohol.

The fresh juice pressed out of apples is sweet because it contains sugar. It is called sweet cider, a pleasant drink. The sugar was formed in the apples as they ripened in the sunshine. The cider does not remain sweet unless the weather is very cold. It loses its sweetness because the sugar changes into the same gas and liquid which form when preserves spoil. It is then called hard cider.

You could not imagine what causes this change.

The change is caused by tiny plants which grow upon the moist sugar. If the sugar is warm as well as moist, the yeast plants grow very rapidly. These plants are so small that they cannot be seen without a microscope. They float in the air. When you look about you in the room, you may think there is nothing floating in the air. If you close the shades, or shutters, and allow a sunbeam to come in beneath one window shade, you see countless specks of dust in the sunlight.

The yeast plant is much smaller than a speck of dust. It can be seen with the aid of a microscope. Yeast plants are usually found on the skins of fruit, as well as in the air. They can do no harm so long

as the skin of the fruit is unbroken, because they cannot reach the sugar. When the apples are crushed, the yeast plants are washed into the juice, and in a few hours, if the weather is warm, they begin to grow. The change produced in the sugar by the growth of the yeast is called **fermentation**. On account of fermentation, it is better to eat the fruit than to drink the juice, unless the latter has been pressed out only a short time before.

FIG. 49. — Yeast Plants.

A Delicious Drink. — The juice of ripe fruit, such as grapes, blackberries, or raspberries, may be made into a delicious drink if the juice is heated as soon as it is pressed out, in order to kill the yeast plants. It should then be sealed while boiling hot, in air-tight jars or bottles, so as to keep out the yeast plant which causes the fermentation.

Sometimes people make blackberry cordial, wine, or persimmon beer, and say that it contains no alcohol because they put in none. If they do not keep the yeast germs out, it is not necessary to put in alcohol, for yeast plants soon produce it. If bubbles of gas are seen in root beer, alcohol is forming along with the gas. About one twentieth of cordial is alcohol; the rest of it is water, sugar, and flavors.

We have found that alcohol is the **product of decay**, or the result of rotting. You need not think it strange that alcohol is a poison. It is so poisonous

that after a good deal of it has formed, it kills even the yeast plants forming it, and then alcoholic fermentation ceases. There is another kind of germ which also gets into the cider if the latter is exposed to the air. This germ forms acetic acid.

Acetic acid is the acid in vinegar which gives it the sour taste. Vinegar is no more a food for man than alcohol. The second fermentation, called acetic acid fermentation, soon changes all the alcohol to acetic acid. The cider has changed to vinegar. If you were to drink a glass of vinegar, it would be very injurious, and there is no advantage in using it in small quantities. Do you remember the reason why some people use vinegar and other seasoning as given in the last chapter? Most of the vinegar sold at the present day is not made from apples and is often adulterated with acids more poisonous than acetic acid. Sometimes silly girls drink weak vinegar to reduce fat. It usually accomplishes the purpose. It does so by breaking down their health. Even if they recover their health, they are weakened for life. It is much easier to retain health than to regain it after it is lost.

A process of decay does not furnish food. The products of decay cannot support life. Food is produced by growth in the sunshine, not by decay. The bright rays of the sun give energy to the plant and enable it to live and store up food for its own use and for the use of animals. It is strange that some men have been deceived so long, that they seek to get life and strength, not from sun-

shine, oxygen, and food, but from things that are rotting.

When we consider the sorrow, sickness, and misery which the use of alcohol brings on the human race, it seems stranger still that the race has been so long in comprehending the true nature of alcohol. Many of the boys and girls now growing up have a chance to learn the whole truth. As men and women they will be able to exert much influence upon those who are ignorant from lack of opportunities for education. Those who have begun the use of alcoholic drinks ignorant of the consequences are to be pitied. Many of them become such slaves to the habit that they have not strength of will to abstain even after learning the truth.

The use of fermented drinks probably began a long time ago, for men were unwilling to throw away grape juice, simply because it had fermented. Grapes spoil quickly and men did not know how to prevent fermentation by the easy method mentioned above. Now with many persons the taste for pure, strengthening food has been changed into an appetite for stimulating poison. Men take advantage of this appetite in order to make money, and make into beer even grain, which keeps sound for a long time. Barley is mostly starch and does not ferment, so it is kept in a warm, moist place until it sprouts; the starch then changes to sugar. The sprouting grain is next heated enough to kill the sprouts; the sugar is allowed to ferment, and thus beer is produced. About one twentieth of beer is

alcohol; about one tenth of wine is alcohol. In Mexico a drink called pulque is made by fermenting the juice of the agave, or century plant. In Russia mares' milk is allowed to ferment and a drink called koumyss is the result.

Water, lemonade, milk, and other healthful drinks satisfy thirst. But stimulating drinks, instead of

FIG. 50.—Most railway managers do not allow a man who drinks alcoholic liquors of any kind to run an engine. If you traveled on a train, would you prefer the engineer of your train to be a drinking man or one who never drank?

satisfying thirst, create an appetite for more. Instead of nourishing, they exhaust. The craving for alcohol leads men to seek stronger drinks than can be made by fermentation alone, so the process of **distillation** is used to concentrate the alcohol in the fermented liquors.

Alcohol boils at a temperature about thirty degrees lower than the boiling point of water. The fermented liquor is heated until it is so hot that the

alcohol boils, and rises as vapor, but not hot enough for the water to boil. The vapor passes through a tube running through a cooler vessel, when it condenses in drops. Strong alcoholic drinks, called distilled drinks, or "spirits," are thus made. They are about one half alcohol. Wine, when distilled, makes grape brandy; cider, apple brandy; pulque, mescal; beer, whisky. If juniper berries are added to the whisky for flavor, the mixture is called gin. In the West Indies, molasses that has fermented is distilled and rum is produced.

Whisky is often diluted with water for the sake of cheapness, and leather, tobacco, and acids are added to restore its strength. Drinks sold as wine are often made of things other than grapes. For instance, the wine called champagne, which is sold in England and America, is made mostly of cider, sugar of lead, and a poisonous berry called cocculus indicus, brought from India to London for the purpose. If a bird in India eats this berry, it dies before it can fly far away from the tree.

Which are more apt to seek a stimulant, calm, brave, strong men, or excitable, nervous, anxious men? Which is more apt to become a drunkard, a man who stops work when he is tired, or one who does not know when to stop, but goes on until he is exhausted? One who is cheerful, or one who has the "blues"? Men do not take alcohol because they like its taste, but because of its dulling effect upon the mind. By means of this effect it hides, for the time, feelings of weakness and thoughts of trouble.

CHAPTER X

HOW WE MOVE

Review Questions. — What is a joint (Chapter I)? Name three kinds of movable joints. What is a ligament? How many bones form the shoulder? What is reflex action (Chapter II)?

How Muscles Work. — The organs used for moving the body are called muscles. The ends of the muscles are usually attached to the bones by strong bands called tendons; the part of a muscle between the tendons is formed of flesh. The lean part of beef is muscle. A muscle is usually attached to two bones which form a joint between the points where the muscle is attached.

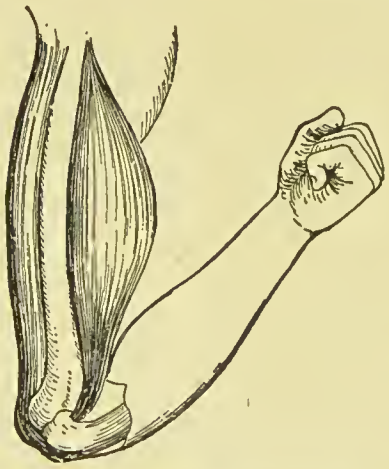


FIG. 51. — The Biceps Muscle.

When a **nerve carries an impulse** to a muscle, the muscle shortens and thickens. The shortening or contraction causes a movement of one of the bones to which the muscle is attached, the other usually remaining in position. The large muscle of the upper arm (the biceps) is fastened at one end to the shoulder blade and at the

other to the forearm below the elbow joint. When this muscle contracts, its middle part swells up, and the forearm, moving on a hinge joint at the elbow, closes up against the upper arm. If you catch hold of an immovable bar above your head, contracting this muscle as you do so, the shoulder is pulled upward toward the bar. Thus a muscle can, at different times, move either of the bones to which it is fastened.

FIG. 52.

The Control of Muscles. — If the head receives a severe blow or shock, the brain suddenly ceases to control the muscles that keep the body upright, and the man faints and falls in a heap. The ligaments, or stout cords at the joints, keep the bones in their places so well that usually only a slight muscular effort is necessary to keep the body erect. This effort is under the control of the nervous system. Such acts as standing, walking, and moving the hands are performed when we will to do so. **Voluntary muscles** are those *usually* controlled by the will. Can you give an instance when voluntary muscles act without an effort of the will?

Other muscles, such as those of the heart and stomach, work without any thought on our part.

We cannot cause them to contract, nor can we stop their action by any effort of our own. Muscles that are *never* under the control of the will are called **involuntary muscles.** Remember that their action is controlled by the nervous system, although not by the will. We did not say that voluntary muscles are *always* under the control of the will. Walking may sometimes be reflex, as in sleep-walking. Nearly every voluntary muscle may contract at the same moment, as when one jumps at the sudden slamming of a door. When we studied the nerves, what did we learn is the name given to such an act?

FIG. 53.
Running is good exercise. Both feet are off the ground together a part of the time.

Structure of Muscle. — If you notice beef that has been boiled a long time, long enough to pull the muscles apart easily, you see that a muscle is made of thread-like parts, or fibers. The microscope shows that each of these fibers is made of still smaller fibers. When a muscle contracts, every one of its fibers thickens and shortens.

Tendons. — What are tendons? Tendons may be felt very plainly in the bent elbow and under the knee. If the muscles contract very strongly, the tendons may feel as hard as bone. They are very strong. The butcher hangs up a whole hog by one tendon. Move the fingers, one at a time, and

see the tendons on the back of the hand rise. The strongest tendon in the whole body is at the heel. Feel it with your fingers and notice it move as you move the foot on the ankle joint.

What name is given to the nerves that carry impressions to the brain? (See Chapter II.) What name is given to nerves that carry orders from the brain to the body? What besides two such nerves is necessary for reflex action?

In voluntary actions, the nerve, acting something like a telegraph wire, takes an impulse from the brain to the muscle, setting the muscle in motion unless it is so fatigued that it cannot act. Let us learn how the muscle gets the strength to move. The muscles continually build up their substance from the oxygen and food brought to them by the blood as it circulates through them. When the nerve excites the muscle to contract, the chemical change called oxidation takes place in the substance of the muscle, which gives off carbon dioxid to the blood At the same time the muscle contracts and becomes warm. What is oxidation?

When gunpowder is exploded in a gun, the shot is forced out and the barrel of the gun becomes hot. The powder in the gun could have been exploded by pulling a string attached to the trigger, or by sending electricity along a wire to the powder. The string or the wire corresponds to the nerve which goes to the muscle. The barrel of the gun corresponds to the muscle cells; the powder corresponds to the food and oxygen stored up in the

muscle. The powder has to be supplied again; likewise, the muscle substance, as soon as it breaks down, has to be built up again by the oxygen from the lungs and the food from the stomach. The waste material of the muscle is carried away by the blood. It is chiefly carbon dioxid.

Benefits of Exercise. — When people have only thin, flabby muscles attached to their bones, they are weak and cannot do much work. See what slim little legs many children in the city have. Children in the country climb hills, do work, and walk a long distance to school. They are more likely to be strong than city children. This is because muscles are developed by use.

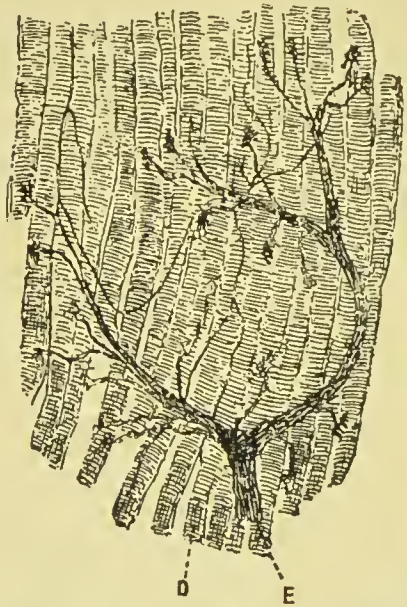


FIG. 54. — Nerve Fibers ending among the muscle fibers which they stimulate to contraction.

Exercise has a favorable effect not only upon the muscles, but upon all parts of the body. Running, jumping, and brisk walking strengthen the arms, legs, and back; but, more important still, such exercise makes the blood flow more rapidly, and a greater amount reaches the various organs. Exercise causes the lungs to expand, because deep breathing is necessary to supply the air. It cleanses the skin and takes off waste matter by causing perspiration;

it develops a better appetite and keeps the digestive organs healthy. Vigorous exercise just after a meal is not good for the digestion; a slow walk or other gentle exercise does no harm. We should not eat when we are very tired. No one should spend all his time doing one kind of work; this brings certain organs into play to the neglect of others. Organs become tired and must have rest, as we have seen when studying the heart. Change of occupation brings different organs into play and gives the tired ones time to rest. A person who has been working all day with his hands or brain is rested by a brisk walk out of doors. The vessels in the tired organs are filled with blood. When the blood vessels in the brain are full of blood, the mind cannot rest. When the other organs are used, the blood is drawn away from the brain, giving it time to recover from the fatigue. One who has been walking all day, as in plowing, is rested by reading.

"The voluntary muscles are very obedient; they do exactly as we tell them. Sometimes they do things without our knowing that we have told them; but that is only because we have told them so often that they have got used to acting without fresh commands. I think it is a very beautiful fact, and it should help us very much to know that our wills can command our bodies, that even our fingers move because we order our muscles to move them. It should help us in times of temptation, for though it is true to say 'the flesh is weak,' it is also true

to say 'the will is strong'; and as the poet has written it —

> "So nigh is grandeur to our dust,
> So near is God to man,
> When Duty whispers low, 'Thou must,'
> The youth replies, 'I can!'"

DIALOGUE BETWEEN FRANKLIN AND THE GOUT

PARIS, Midnight, October 22d, 1780.

Franklin. — Eh! oh! eh! What have I done to merit these cruel sufferings?

Gout. — Many things; you have eaten too freely and too much indulged those legs of yours in their indolence.

Franklin. — Who is it that accuses me?

Gout. — It is I, even I, the Gout.

Franklin. — What! my enemy in person?

Gout. — No, not your enemy.

Franklin. — I repeat it — my enemy; for you not only torment my body to death, but ruin my good name; you reproach me as a glutton, and all the world that knows me will allow that I am not.

Gout. — The world may think as it pleases, but I very well know that the quantity of meat and drink proper for a man who takes a reasonable degree of exercise would be too much for another who never takes any.

Franklin. — I take — eh! oh! — as much exercise — eh! — as I can, Madam Gout. You know my occupation, and on that account it would seem,

Madam Gout, as if you might spare me a little, seeing it is not altogether my own fault.

Gout. — Not a jot; your rhetoric and your politeness are thrown away; your apology avails nothing. If your business requires much sitting, your amusements, your recreations, at least, should be active. But let us examine your course of life. While the mornings are long and you have leisure to go abroad, what do you do? Why, instead of gaining an appetite for breakfast by healthful exercise, you amuse yourself with books, pamphlets, or newspapers which commonly are not worth the reading. Yet you eat a large breakfast — four dishes of tea, with cream, and one or two buttered toasts, with slices of hung beef, which, I fancy, are not the things most easily digested. Soon afterwards you sit down to write at your desk or converse with persons who apply to you on business.

Thus the time passes till one, without any kind of bodily exercise. But all this I could pardon, in regard, as you say, to your business. But what is your practice after dinner? Walking in the beautiful gardens of those friends with whom you have dined would be the choice of a man of sense; yours is to be fixed down to chess, where you are found engaged for two or three hours! This is your perpetual recreation, which is the least suitable of any for a sedentary man, because, instead of hastening the motion of the fluids, the rigid attention it requires helps to retard the circulation and obstruct internal secretions What can be expected from

such a course of living but a body full of impurities, ready to fall a prey to all kinds of dangerous maladies, if I, the Gout, did not occasionally bring you relief by disturbing those impurities. Fie, then, Mr. Franklin! But amid my instructions I had almost forgot to administer my wholesome corrections; so take that twinge — and that!

Franklin. — Oh! eh! oh! oh-h-h! As much instruction as you please, Madam Gout, and as many reproaches, but pray, madam, a truce with your corrections!

Gout. — No, sir, no, I will not abate a particle of what is so much for your good; therefore —

Franklin. — Oh! eh-h-h! It is not fair to say I take no exercise, when I do very often, going out to dine and returning in my carriage.

Gout. — That, of all imaginable excuses, is the slightest and weakest, if you allude to the motion of a carriage suspended on springs. By observing the degree of heat obtained by different kinds of motion, we may form an estimate of the quantity of exercise given by each. Thus, for example, if you turn out to walk in winter with cold feet, in an hour's time you will be in a glow all over; ride on horseback, the same effect will scarcely be perceived by four hours' round trotting; but if you loll in a carriage, such as you have mentioned, you may travel all day and gladly enter the last inn to warm your feet by the fire. Flatter yourself, then, no longer that a half hour's airing in your carriage deserves the name of exercise. Providence

has appointed few to roll in carriages, while it has given to all a pair of legs, which are machines far more convenient and useful. Be grateful, then, and make a proper use of yours.

Franklin.— Your reasoning grows very tiresome.

Gout.— I stand corrected. I will be silent and continue my office; take that, and that!

Franklin.— Oh! oh-h! Talk on, I pray you!

Gout.— No, no. I have a good number of twinges for you to-night and you may be sure of some more to-morrow.

Franklin.— What, with such a fever! I shall go distracted. Oh! eh! Can no one bear it for me?

Gout.— Ask that of your own horses; they have served you faithfully.

Franklin.— How can you so cruelly sport with my torments?

Gout.— Sport! I am very serious. I have here a list of offenses against your own health distinctly written and can justify every stroke inflicted on you.

Franklin.— Read it, then.

Gout.— It is too long a detail but I will briefly mention some particulars.

Franklin.— Proceed. I am all attention.

Gout.— Do you remember how often you have promised yourself a walk the following morning, saying at one time it was too cold, at another too warm, too windy, too moist, or what else you pleased, when in truth it was too nothing but your love of ease?

Franklin.— That, I confess, may have happened occasionally, probably ten times a year

Gout. — Your confession is very far short of the truth; the gross amount is one hundred and ninety-nine times.

Franklin. — I am convinced now of the justness of Poor Richard's remark that "Our debts and our sins are always greater than we think for."

Gout. — So it is. You philosophers are sages in your maxims and fools in your conduct.

Franklin. — But do you charge among my crimes that I return in a carriage when I dine out?

Gout. — Certainly; for having been seated all the while, you cannot object to the fatigue of the day and cannot want, therefore, the relief of a carriage.

Franklin. — What, then, would you have me do with my carriage?

Gout. — Burn it if you choose; you would at least get heat out of it once in this way; or, if you dislike that proposal, here's another for you: observe the poor peasants, who work in the vineyards and grounds about the villages of Passy; you may find every day among these deserving creatures four or five old men and women, bent and perhaps crippled by weight of years and too long and too great labor. After a most fatiguing day these people have to trudge a mile or two to their smoky huts. Order your coachman to take them home. This is an act that will be good for your soul: and at the same time, if you return on foot, that will be good for your body.

Franklin. — Ah, how tiresome you are!

Gout. — Well, then, to my office; it should not be forgotten that I am your physician. There!

Franklin. — Oh-h-h! What a horrible physician!

Gout. — How ungrateful you are to say so! Is it not I, who in the character of your physician, have saved you from palsy, dropsy, and apoplexy, one or other of which would have done for you long ago, but for me?

Franklin. — Oh! oh; for heaven's sake leave me, and I promise faithfully never more to play at chess, but to take exercise daily, and live temperately.

Gout. — I know you too well. You promise fair, but after a few months of good health you will return to your old habits; your fine promises will be forgotten like the forms of last year's clouds. But I leave you with an assurance of visiting you again at a proper time and place; for my object is your good, and you are sensible now that I am your real friend. — By Benjamin Franklin (abridged).

Review Lesson. — Describe the heating of the "tobacco heart." Why were many volunteers rejected during the war with Spain? Relate the experiences of the men that went to the arctic regions to find Sir John Franklin. What effect has tight clothing upon the circulation? Give examples of four kinds of tight clothing. Show how the health of each of the following organs is dependent upon a good circulation: the brain, the muscles, the stomach, the skin, the bones.

CHAPTER XI

THE COVERING OF THE BODY

The skin, under the microscope, is seen to consist of two coats, the lower, or inner one, called the **dermis**; the upper, or outer one, called the **epidermis**, or scarf skin.

The epidermis is composed of several layers of cells, all of which are flattened and horny except the *lower layers* near the dermis. Near the dermis the cells are soft and more nearly round. The cells of the epidermis lying next to the dermis contain the coloring matter of the skin; it varies in amount with different races and peoples.

The dermis, or inner coat, is made of tough fibers and contains nerves and blood vessels. Beneath the dermis is found a layer of fat which acts as a cushion and prevents the heat of the body from escaping into the air.

The skin protects the softer tissues beneath, and since it is elastic, it prevents the blood and lymph from collecting in the blood vessels of the lower part of the body.

At the lips and nose, the skin changes into a soft and more delicate covering, called the **mucous membrane**, which extends into the body and forms the lining of most of its organs. You can understand

that food in the mouth or alimentary canal is not a part of the body and is not really in the body. To get into the body it is necessary to pass through the skin or mucous membrane.

The epidermis may be raised up and separated from the dermis. This happens in the case of a

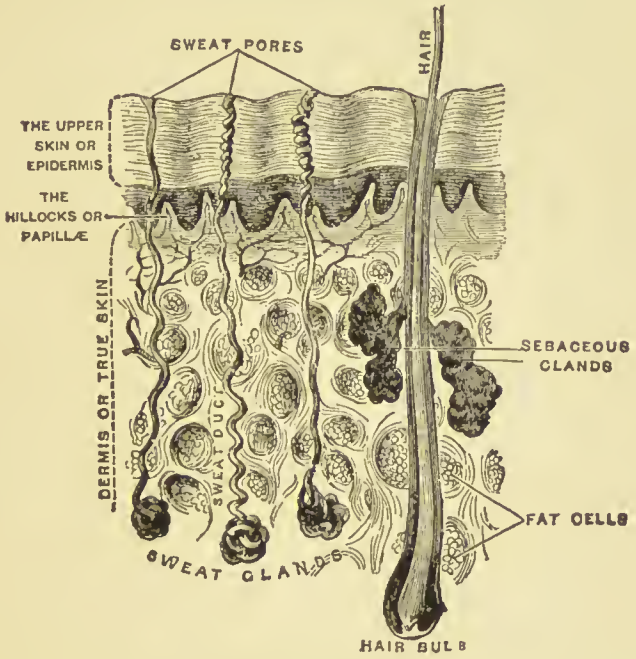


FIG. 55.—The Skin as it would look if sliced through and viewed under a microscope.

blister, when watery material or blood is forced between the two layers of the skin. The delicate, pink skin seen beneath the blister is the surface of the dermis, or true skin.

The outer skin has no nerves or blood vessels. Boys have proved this by putting a pin through the outer skin, without causing the blood to flow as it does when a blood vessel is cut. Nor does

the entrance of the pin cause pain, as it would do if a nerve had been touched. If there were no outer layer, we should suffer pain and injury all the time, from objects touching the nerves or hurting the blood vessels.

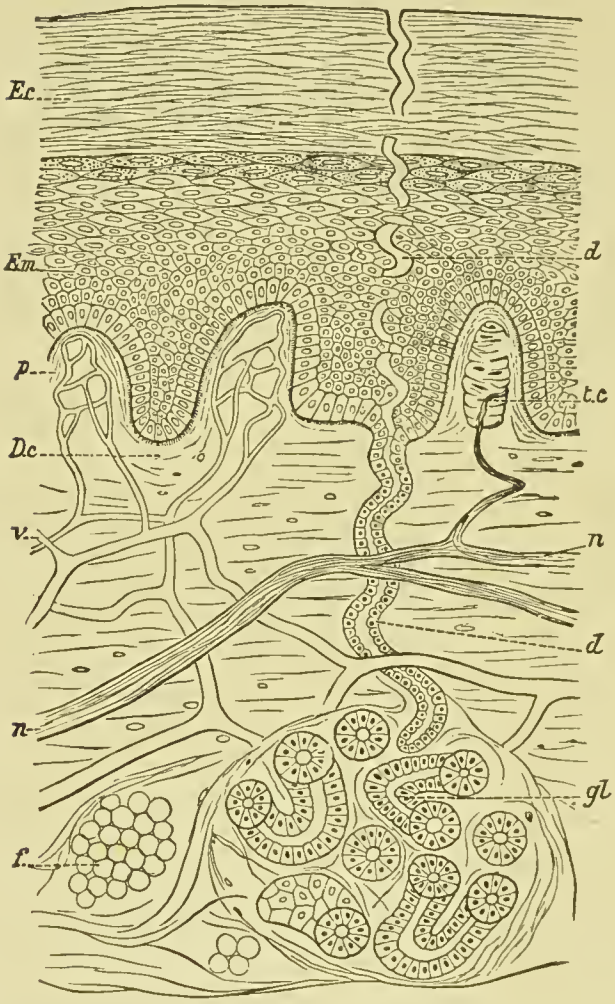


FIG. 56.

The Skin, more highly magnified than in Figure 55. The outer layers of the scarf skin are dead. See *E.c.* The outer skin is being built up continually from the layers of live cells at *E.m.* All the rest is dermis, or true skin; it is full of veins (*v*) and nerves (*n*). The nerve ends in a coil in a little oval body *t.c.* *gl* is a sweat gland; trace it to the surface.

The scarf skin may be said to consist of a countless number of horny cells or scales, laid one upon another, as you might imagine the covering of a fish which had a dozen or more layers of scales. Only you must remember that the scale of a fish is a thousand times as large a scale, or flat cell, in the scarf skin.

The outer cells of the skin are constantly wearing off and new ones are growing beneath, next to the true skin. Snakes, lizards, frogs, and insects put off the whole skin all at once. You may have found the skin of a snake lying on the ground after it had been shed. Birds moult, or lose their feathers, one at a time, and new ones come in their places. We shed our skins in such tiny, powdery scales that we do not notice them. If one rubs hard while taking a bath, the epidermis sometimes peels off in little white rolls. The skin of the scalp sometimes becomes coated with dandruff. There is usually some dandruff, even on the healthiest and cleanest scalp. Yet careful and cleanly persons by brushing the scalp prevent it from becoming coated with dandruff.

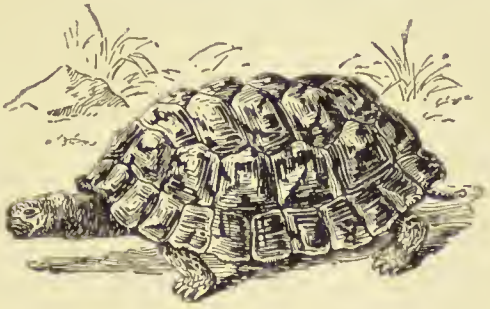


FIG. 57.
The Skull of the Tortoise is chiefly of epidermis, supported by the ribs.

FIG. 58.—Two Hairs with their Oil Glands.

The **hair and nails** belong to the skin. The hair grows from little sacs or bags in the skin, and the nails grow from grooves or folds in the skin. The hair is made of scales like those of the scarf skin. Some of the cells contain pigment, or coloring matter, which gives them their color. This pig-

ment ceases to form in the hair of very old persons. To the roots of the hair muscle fibers are attached, enabling the hair to stand on end. You may have seen a cat bristle up when a dog came near.

Each hair is oiled by two little **glands** at its side. The oil which they furnish is a natural dressing for the hair. This oil softens the skin and also keeps the hair soft and glossy. Well-kept hair is one of the most beautiful ornaments of the body.

The oil glands on the nose are relatively very large, although the hairs on the nose are very small. Sometimes the openings of the glands become swollen by the oil and dirt which fill them. When in this condition, they are called blackheads. The use of face powder frequently causes blackheads. By keeping the face clean, the swollen openings gradually decrease to their natural size.

Sometimes the face and hands chap, that is, the skin becomes hard, and cracks for the want of oil. Some other oil or cream is put on to fill the place of nature's hair oil. Thorough brushing of the hair makes the glands more active, and the hair glossy and smooth. A brush which irritates the scalp should never be used.

"Long and thick hair is such a great beauty, that it is curious why more girls do not take pains to obtain it. Cleanliness and frequent brushing are the best ways to get good, long, and thick hair. The people in different countries have different ideas about hair. The women in Egypt and the Eastern lands do not think it modest or becoming to show

any hair at all, and they cover their heads and ears with long draping cloths, while the ladies of Japan undergo the most elaborate hair-dressing. Indeed, the process takes so long a time that it is not usually done more than once or twice a week. Each hair is brushed and pomatumed and gummed until it lies in its proper place. To rest the head on a pillow would upset it all, so the Japanese women forego pillows, and sleep resting the head on small neck-rests, which allow the hair to remain untouched. Is it not a strange custom?" — MRS. S. A. BARNETT.

FIG. 59. — Sweat Glands.

FIG. 60.
Magnified view of the Skin, showing the pores, or openings of the sweat glands.

There is another kind of glands called **sweat glands.** The perspiration, or sweat, is collected by the glands. It is not pure water, but contains impurities which would harm the body if retained. The openings of the sweat glands are called pores. Besides removing impurities from the body, another function of the sweat is to cool the body. When the weather is hot, or when we work hard, the skin becomes flushed with blood, and the sweat flows so freely that it stands on the skin in little drops. We are always perspiring whether we are warm or not, although we may not see the sweat on account of the smallness of the quantity.

The evaporation of the sweat from our bodies cools them. This cooling of the surface also cools the blood, because a great amount of it is brought to the surface of the body. The body is sometimes cooled by damp and wet clothing. If you are caught in the rain, the dampness will do no harm, so long as you keep moving, and keep the body warm by exercise. Damp clothes or shoes should be changed for dry ones as soon as possible.

FIG. 61. — Flax with Blossoms.

Linen, suitable for clothing in warm climates, is made from the stems of this plant.

The **nails** protect the ends of the fingers and toes. They are like beautiful pink shells if they are kept clean. Nails should be cut regularly. Some people have the habit of biting the nails. This is a very bad habit; it makes the fingers not only sore, but stumpy at the ends, so that it is impossible for them to do the delicate work for which they are intended. The nails have a natural polish and should not be scraped with a knife.

Impurities may enter the body through the skin. Cheap toilet soaps, perfumed to hide the rancid odor, are sometimes made from the fat of diseased animals. By use of such soaps, impurities may be taken into the body through the pores of the skin. Sometimes soldiers, in order to shirk duty, put a piece of tobacco in each armpit. The poison that is absorbed reaches their nerves;

they become sick, and the surgeon sends them to the hospital.

Painters who do not keep their hands clean suffer at times from what is called painters' colic, caused by the lead that is absorbed through the skin. Hair dyes and face powders, or even stockings that are poorly dyed, may injure the skin. Cos-

FIG. 62. — Twig of Mulberry, and Eggs, Caterpillar, Cocoon, and Chrysalis. Moth, and Silkworm that spins silk, a fabric warmer than cotton but cooler than wool.

metics sometimes cause dark spots or sore places on the cheek, or pimples in the face. Nothing but pure blood and good health can give a clear skin and rosy cheeks. It has been said that "beauty is but skin deep." Explain why this saying is false.

It is one of the sad things in life to see the roses fade from the cheeks of healthy and happy boys and

girls because they cannot or will not live in the pure air, take enough exercise, and dress properly.

The pale and sallow skin of the cigarette smoker shows what havoc the poison makes with health. The odor of tobacco is continually passing through the skin to the clothes of the user, until they become so filled with it that they may even be offensive to persons passing along the streets.

Care of the Skin. — The first condition for keeping the body clean is to live in a clean house. Every child should learn to shun dirt, and to understand the danger that lurks in it. He should learn to remove dirt, not to hide it. If, after a room is

FIG. 63.

FIG. 64.

FIGS. 63–64. — Natural Feet and Deformed Feet. Should the shoe be longer in the middle or on one side ?

swept, the dust is allowed to settle upon the furniture and the tops of the picture frames, the position of the dirt has only been shifted from one place to another. It might as well have been left upon the floor. Rooms should **be thoroughly aired while they are being swept and for a long time after**, in order to get rid of the dust. All unnecessary things

should be removed from a room and stored in a proper place until needed. Otherwise they simply become traps to catch and hold dust.

The two *kidneys* help the skin to keep the body pure. They are in the back part of the waist, one on each side of the back bone. They look like two large bluish brown beans. They secrete water and injurious salts and remove poisons. By drinking plenty of pure water, the sweat glands and kidneys will have enough water to wash out impurities.

FIG. 65. — Cotton Blooms. Cotton clothing does not shrink like wool, and costs less. It is not eaten by moths, and it takes up and dries out sweat instead of making the skin moist and clammy like wool.

The *bath* should be taken in a warm room. We should try to get used to cool baths and a dash of cold water at the end of the bath. The skin should be rubbed until it glows. All persons cannot safely remain in the bath for the same length of time. It is not safe for weak people to take very hot or very cold baths. It is best to take a warm bath in the

evening just before going to bed. If it is taken just before going out of doors, a cold is likely to follow — especially if the dash of cold water is omitted at the end. It is best to take a cold bath upon rising in the morning.

Exposure after a warm bath, or cooling off suddenly when one is perspiring, may cause a cold by stopping the perspiration for a considerable time. A bath should not be taken just after eating. When bathing, one should not stay in the water until he is chilled.

LIFE IN THE VILLAGE OF X

A few years ago the village of X could be seen nestling among the trees on the banks of a river which flows through one of our great states. Its people were intelligent, simple-hearted, and prosperous. Soon a railroad was built through the village, which began to grow. The stores, which had been few, increased in numbers, and factories were built upon the river bank.

The traveling men who came to sell goods to the merchants told the clerks and other young men that their town would never prosper, and they themselves would never amount to anything, unless they dressed according to the fashions of London and Paris. Thereupon, the young men ordered hats, shoes, and clothes of the kind that the traveling men wore and had for sale. Now it seems that there were many dandies in Paris who had nothing to

do but to waste the money and tarnish the good names that their fathers had left them. They idled, stiffened their necks, and held their heads high because of what their fathers had done. Their necks became very thin and lean, so they had collars made which came up nearly to their ears and hid their necks. The young men in the village of X soon had their stout and manly necks incased in collars of the same height; but they led busy lives and could not hold their necks stiff enough to keep from rasping them upon their collars. From over-protection, their necks became so sensitive that they had many colds, coughs, and lung troubles. It was much warmer in X than in Paris, but they clung to their tall collars and sweltered all the summer through. The gay young men of Paris changed the shape of their hats and the cut of their coats quite often, for they had little to think of but clothes. When the baker and butcher boys of Paris, and the clerks and other young men of the village of X, adopted the new fashions, the dandies at once changed again, for they could not bear to see so common men dressing as they did. The clerks could not bear to dress any other way, because they thought that was the only way to live; for so the drummers who wanted to sell them the clothes had told them. The rich young men in Paris wore tight shoes and drove in their carriages; the young men in X wore tight shoes and trudged. Corns and bunions came, which caused them to suffer cruel tortures.

Some of the maidens in the village of X went off to boarding school, where they learned to paint pretty blue roses and other flowers and to repeat a few sentences in French. The most important thing they learned was to make their clothes like the pictures in the monthly *Excruciator* and another magazine called *La Mode de Paris*. The sisters of the millionaire dandies of Paris and London wore their dresses very long to display the fine fabric. When they went out, they had only to step into their carriages standing under the covered driveway of their mansions. The young ladies in the village of X at once had their skirts made of equal length and carried them until their arms ached; and then they dropped them and dragged them through the filth of the street until their backs ached. Later they hung the soiled skirts in the closets of their homes. The rich lady in the city would have her measures taken by the corset maker, who for ten dollars would make a corset to fit her form; the maiden in the village would buy a cheap, ready-made corset for two dollars, and fit her form to it. The ladies in Paris ruined their complexions by much indoor life and overeating and had to cover their dingy faces with powder and paint; so the maidens in the village covered their smooth, rosy skins with cosmetics and made them dingy too. The city ladies, before going to balls, would have their hairdressers come, and while reclining upon easy-chairs, their hair would be done into many a curl and ringlet. The village maidens struggled for

an hour, until their arms ached with the tedious crimping. When with tired hands and hair scorched by hot irons, they went to parties, they were too tired to enjoy themselves, although most of them had strength enough left for their most popular amusement, a game called "Simon says wigwag." The rich ladies had many fine hats. They had also ladies' maids to care for their finery when they went on journeys; the maidens in the village of X (is it a long way from here?) tried with cheaper material to make hats equally gorgeous, but when they went on journeys they lugged their bandboxes along with their own hands.

A traveler in Paris told the Countess of B. about these doings and she laughed a silvery little laugh, which she had been taught at a fashionable school, and said, "Poor, silly things!" The fine ladies gave away their dresses and had others made each season in a new fashion; the girls of the village could not afford to waste good cloth, so with much time and labor and contriving, they made over their dresses; or at first they often made them of flimsy material which soon wore out, resulting in waste of time and labor. The fine ladies cut off their breath with tight clothes, and while dressed up, never made any exertion even so much as to call a servant, merely pressing the button of the electric bell when one was needed. The young ladies in the village of X cut off half their breath of life, talked in strained tones to forty school children, sat at sewing machine or typewriter, or stood behind a counter all day, or

did some other useful thing, such as a fine lady seldom does, so they became haggard and broken before their time. A lady visited the town and gave a talk to the ladies' club on artistic, healthful dress, and showed how tight clothing makes the muscles weak and flabby, and causes the human figure to lose all its natural gracefulness; but she failed to convince the women of X.

An artist who was painting the beautiful scenes near the village perceived the folly and ugliness of the prevailing styles, and wrote a letter to the weekly newspaper, in which he said that nothing shows lack of refinement so much as affectation of tone or voice, or imitation of the ways of others; that people of self-respect live their own true lives, and do not lose health and happiness copying other people; that Americans can have as much taste and individuality as the people of any other country; that when it is the style to wear "cart-wheel" hats, the woman with a small face should not do so, or her face would look like a bullet, as he uniquely expressed it; that a woman with a very large head should not adopt the fashion when hats become the size of saucers, or her head would seem as large as a water bucket; that a woman with a long nose who wears her hat on the back of her head because others do so, makes it seem like a day's journey from the hat to the end of her nose, and that a pug-nosed woman who wears her hat low on the forehead, makes her nose seem to point skyward still more. The artist said, too, that fat women who wear tight

dresses simply show how dumpy they are; that thin ones who wear them lead kind-hearted friends to think they need to go to the hospital; and that neither a stovepipe nor a stovepot is a good model for a man's hat, etc.

But the artist's words had no effect upon the fashionable girls and young men whose only idea was to make themselves conspicuous by coming out in every new fashion, however ugly or unhealthful. But their conduct amused the few old-fashioned girls of the village, who were ruddy-faced and strong from leading simple, active lives. They made their dresses of fine, durable cloth which lasted several years, and only laughed when the other girls told them they looked as if they had come out of the ark. These old-fashioned girls and their brothers still sang the sweet old songs instead of the ragtime tunes that the stylish boys and girls sang; they still read the beautiful old books instead of the latest novels that the others read. When the old-fashioned girls married, they had strength and health that made them good housekeepers and cheerful wives. On the other hand, the stylish girls at twenty-five looked like old women; they were always having aches and pains, and when the husband of one of them saw the number of bottles of medicine on the shelves, it seemed as if he lived in a drug store instead of a home. The women of style said they were sick because God intended woman to be weak and sickly.

Of course the rich idlers of Paris and London

were slow to believe the scientific proofs of the poisonous effect of alcoholic drinks and they still used such liquors. When the village gave a public banquet in honor of a senator who visited there, the stylish young men said it would not be fine enough without champagne. The people of temperance principles turned their glasses down when the champagne was passed around. It was a mixture of even poorer stuff than fermented grapes; but the young men were happy, for they thought it the same as that drunk by the people they were trying to ape.

Some of the young men of the town injured their health much more by indulgence in cigarettes and beer than the girls hurt themselves by tight clothes and lack of exercise. Many of the men went in vain hope to inebriate asylums, while the women visited noted surgeons in the large cities, hoping to be cured of chronic ill-health. Thus much money went out of the town and with intemperance and doctors' bills and drug bills, and quantities of goods in the stores that were out of style, the people had a hard struggle instead of prospering as the commercial travelers had promised some years before when the village was small. But the people of X had grown wiser as well as older. They taught their children that being a lady or a gentleman does not consist in wearing fine clothes or in copying the clothes and habits of others, but in being modest and gentle and honorable; that health and happiness come, not from pride and display, but from simplicity and truth.

CHAPTER XII

THE SPECIAL SENSES

THERE are **five ways** by which we may receive messages from the world about us: Through — 1. The eye, sensitive to **light**; 2. The ear, to **sound**; 3 The nose, to **smell**; 4. The tongue, to **taste**; 5. The skin, to **touch, heat,** and **cold.**

No organ can perform the function of another organ; the eye cannot hear, the nose cannot taste, the ear cannot see. Pressure on the eye may cause a man to see forms, and a sudden jar or jolt may make him "see stars," because the nerve of sight feels pressure or jars. In olden times men counted seven special senses instead of five; the two additional senses were the "voice" and "animation," or life. The voice is not a sense, but a result of muscular action, and as to animation, or life, no one knows what it is. Hence we may say we have five special senses.

We have also a **general sense** which acts through nerves that come from the blood vessels, lungs, and digestive organs, and tells us the condition of our own bodies. It is by the general sense that we "feel well" or "feel ill." Beyond this, we are not usually conscious of digestion, breathing, or the circulation of the blood.

Pain is the result of any one of the sense organs being too strongly stimulated. Pain is very useful to us, for it warns us when to take care of ourselves.

TOUCH

The true skin projects into the epidermis, or scarf skin, forming tiny hillocks or ridges. (Fig. 56.) In most of these projections, small oval bodies, known as touch corpuscles, are found. A nerve fiber ends in each of the corpuscles. By means of these nerve fibers in the skin, we feel the sensation of touch and pressure, heat and cold. By touch we can tell whether an object is hard or soft, rough or smooth, etc. In what part of the body are the nerves of touch very numerous? (Chapter II.) The ridges in the palm and fingers show where rows of projections containing the touch corpuscles are found.

The muscular sense consists of the special sense of touch and the general sense. By means of pressure on the skin and on the sensory nerves which end in the joints and muscles, we learn the position of the body and limbs and how much effort our muscles are making.

TASTE

The surface of the tongue is roughened by numerous little projections. In some of them are found the ends of the fibers of the nerves of taste. Things taste (1) sweet, (2) sour, (3) bitter, or (4) salt. Flavors are not detected by the sense of

taste, but by the sense of smell located in the nose; hence a cold in the head destroys the flavors of food we eat. An apple seems without flavor if you hold your nose when you bite it, although it still tastes sweet.

Substances must be dissolved in a liquid before they can be tasted, because only liquids can affect the nerves of taste. Soluble substances not in a state of solution are readily dissolved by the saliva. The sweetness of sugar can be tasted if there is only one part of sugar to 83 parts of water, while the deadly poison called strychnine can be tasted, as bitter, if there is only one part of strychnine in 2,000,000 parts of water. Coffee has a bitter taste. The first man who used it could not have had any respect for his natural instincts. Sometimes children, by putting milk and sugar into coffee in order to hide its taste and deceive the faithful tongue, learn to like it; but they should never drink it. Tea is no better than coffee. Many grown people use tea and coffee and seem to escape evil effects by using them moderately. On the other hand, many people find by ceasing to drink tea and coffee, that headaches, indigestion, and other troubles are cured at once.

Few people like to drink pure coffee. In some sections of the United States and in many countries of South America, there are coffee topers who are enslaved by its use. The Brazilian topers, who drink twenty to thirty cups daily, say that coffee, to be good, must be as black as night, as

bitter as gall, and as hot as fire. They drink it for its effect, not for its taste.

SMELL

The nose is divided in the middle by a partition of bone and gristle, making the two nostrils. The floor of the nose and the roof of the mouth are formed by one partition called the hard palate. The floor of the skull is pierced in front by a number of small holes through which branches of the nerve of smell pass into the nose from the brain.

We breathe chiefly through the lower part of the nose and smell with the upper part. By sniffing, air is drawn into the upper part of the nose and an odor is more easily detected. In many of the lower animals the sense of smell is far more sensitive than in man. Give an instance that shows how wonderfully acute smell is in lower animals. The sense of smell in some persons is so injured by catarrh that they have almost lost it. Civilized men do not have so acute a sense of smell as savages; this is because the former make very little use of this sense in selecting their food.

How we Smell. — The perfume of a flower or the odor of any substance which we smell is caused by tiny particles of the object floating through the air to the nose. These particles are too small to be seen even with a microscope, but they touch the nerves of smell and give us the odor. The sense of smell not only enables us to choose good food and

to avoid spoiled food, but it also warns us to keep away from unhealthful and unpleasant places.

SIGHT

Touch, taste, and smell bring us in contact with the bodies that we perceive through these senses. But the senses of sight and hearing give us knowledge of things at a distance as well as of those at

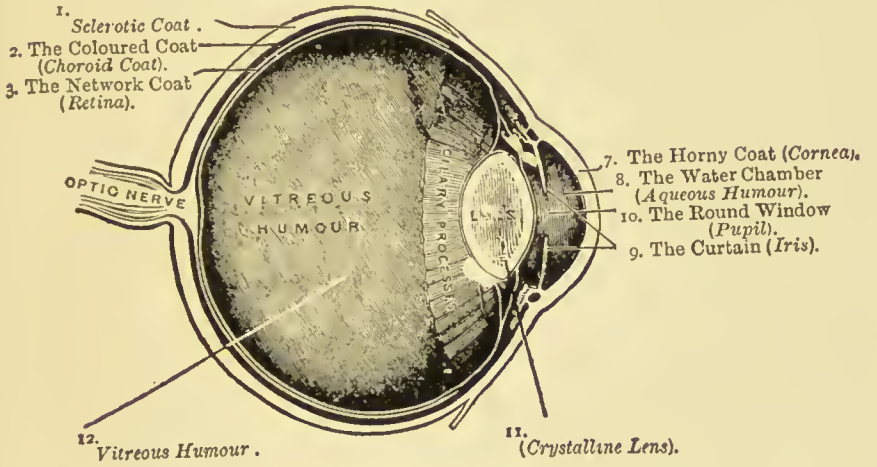


FIG. 66. — Section of Eyeball, showing its two chambers, etc.

hand. The sense of sight enables us to look at a thing within a few inches of our faces one second, and at something else, miles away, the next second. There are things so far away that nobody has ever measured the distance, yet we can see them. What are they?

The eyeball is set into a deep bony socket. There is a cushion of fat between the eye and the hard wall of the socket; this cushion sinks in when

the eye is struck, so that the eye may not be injured. A large nerve, called the **optic nerve**, goes from the brain to the eyeball, passing through an opening in the back part of the socket.

The eyeball is tough and almost round. Its tough outer wall or covering is lined with delicate membranes. Most of the wall is white, but the front part of the wall, called the **cornea**, is colorless like glass, and bulges out a little. If you look for it in a mirror, you cannot see it well in your own eye. If you look at the side of another person's

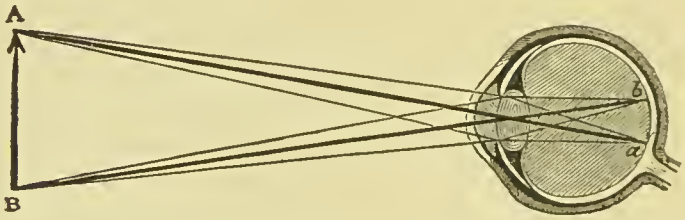


FIG. 67. — Showing how the Lens brings the Rays of Light from an object to a focus on the retina and forms a small image.

face, you can see the transparent cornea bulging out in the front part of the eyeball. Behind the cornea is a space filled with a watery fluid, forming the front chamber of the eye. At the back of this chamber hangs a curtain called the **iris** (meaning rainbow), which gives the color to the eye. The color of the iris is due to the pigment it contains. Persons with much pigment in the skin, making it dark, usually have dark eyes also. In the center of the iris is a hole called the **pupil**.

When we go from a dark room into a lighted room, the eyes are pained by the entrance of too

much light. Soon the iris contracts around the pupil, which becomes smaller and smaller, until it shuts out enough light to cause the pain to cease. In going from a light room into a dark room, one is unable to see anything at first. By and by the pupil of the eye dilates, until it admits sufficient light to enable one to see things clearly.

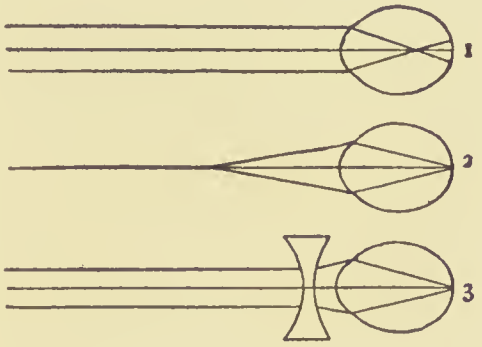


FIG. 68.

Just behind the iris and the pupil is a transparent rounded body called the **crystalline lens.** This lens brings the rays of light to a point, or focus, in the back of the eye, so that a picture is formed. There is a chamber in the eye behind the lens, much larger than the chamber in front of the lens.

This chamber contains a clear, jellylike substance. The optic nerve spreads out on the lining of this chamber. Its lining is called the retina (ret′-i-na). Upon the retina the light is brought to a focus, forming pictures which remain for a moment and then gradually fade away. A bright light looked at for a short time may still be seen as a dim image for a few seconds after the eyes are closed and the head turned away.

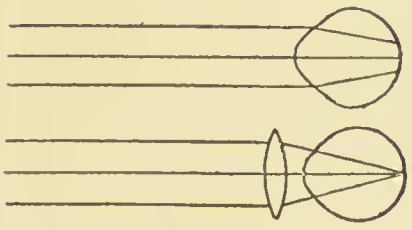


FIG. 69.

For the same reason a stick with a glowing coal at one end, whirled around at night, looks like a bright ring.

Without the optic nerve to carry the impression to the brain, we could really see nothing. Although the picture might be made in the eye, we could not see it unless the brain could get the message.

Nearsightedness is caused by the eyeball being too long, the light coming to a focus before it reaches the retina. (Fig. 68.) **Farsightedness** is caused by the eyeball being flattened slightly, the light coming to a focus behind the retina. (Fig. 69.) The figures show the two forms of eyeball, and the kind of lenses used in glasses for each kind of eyes.

Care of the Eye. — We should be careful to have our work fifteen inches or more from the eye. If we put the head down close to the work, we are in danger of becoming nearsighted. Fine print and fine sewing or embroidery are bad for the sight, because we are apt to bring them too near to the eyes.

The light should not shine directly on the eyes. We should never gaze at a bright light. If the eyes feel in the least tired, we should rest them. The light should come over the shoulder when we are reading. When we are writing, the light should come over the left shoulder. We should not rub the eyes. We should not read when lying down, or in the twilight, or when recovering from any sickness, or for a long time after recovering from scarlet fever or measles. The use of tobacco may seriously injure the sight.

THE HEARING

Why is it almost as great a misfortune to be deaf from birth as to be blind? (What usually accompanies deafness?)

The ear has three divisions, called the **outer, middle,** and **inner** ear. We can see the part of the outer ear that is outside of the skull. It is com-

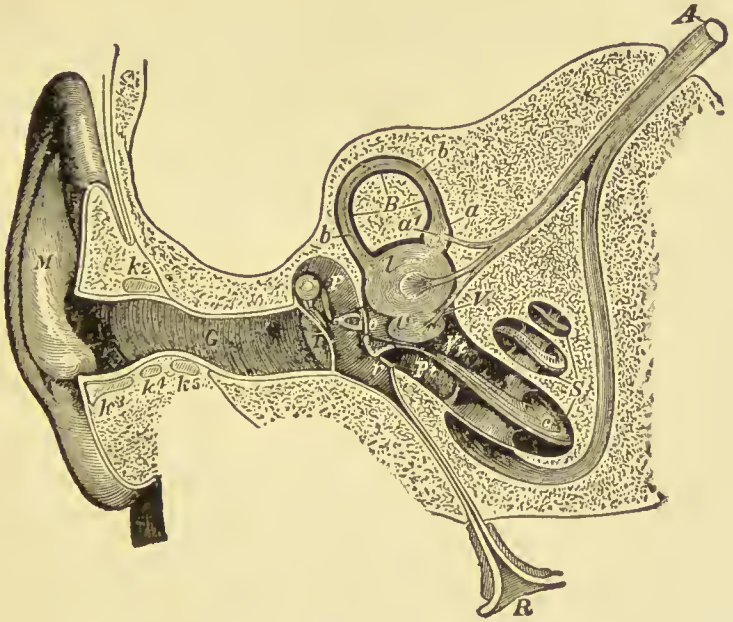


FIG. 70.—The Ear.

posed of cartilage and is formed to catch sound. The outer ear continues inward in the form of a tube, which is about an inch long. Across the inner end of the tube a delicate membrane is stretched. It is the drum skin, although often called the drum. The middle ear is the drum; it is a cavity containing air, situated just beyond the drum skin. Three of the tiniest bones in the body,

called the hammer, anvil, and stirrup, stretch across the drum cavity from the drum skin to the inner ear.

The inner ear is a bony cavity made up of small spiral tubes and loops, hollowed out in the solid bone. This complex cavity is filled with a liquid. The nerve of hearing passes from the brain to the inner ear and its many fibers come to an end in this cavity.

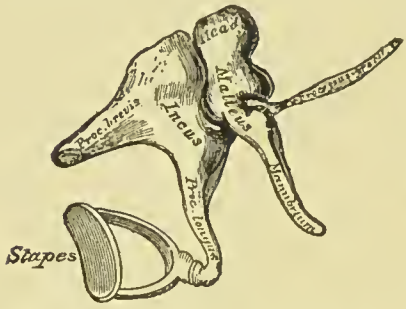


FIG. 71. — The Three Bones of the Ear (magnified four times).

The Hammer is more like a club than a hammer; the anvil is something like an anvil; while the third bone is as neat a little stirrup as one could wish to see.

Sound travels in waves that follow one another rapidly. When you throw a stone in a pond, you see circular waves starting from the point where the stone struck. Sound waves are in the air like spheres instead of like circles, and spread in all directions from the source of the sound. Reaching the ear, the waves pass through the canal of the outer ear and set the elastic drum skin to shaking, just as a drum vibrates when it is struck. The three little bones are set to vibrating in turn, and the last of the three bones, called the stirrup, sets in motion the liquid of the inner ear. This liquid makes an impression upon the ends of the nerve fibers. The nerve of hearing (*A*, Fig. 70) carries a nerve current (not a sound wave) to the brain.

A tube leads from the middle ear and opens into the throat behind the nasal passages. (*R*, Fig. 70.)

A chronic cold in the head may affect the ear through this tube and injure the hearing.

Care of the Ears. — Cold water should never be put into the ear. Diving in deep water or bathing among the breakers sometimes injures the ears. If there is water in the ears after bathing, the head should be held to one side and the water allowed to run out. Earache is sometimes caused by sleeping where the wind may blow upon the ears. Putting cotton into the ears to protect them from the cold only makes them more sensitive. Never pick the ears, as by so doing the drum skin may be injured. The tube of the outer ear secretes a yellow, bitter wax, which prevents insects from entering the ear.

REVIEW LESSON. (*Health of the skin.*) — What is the only way to have a beautiful skin? What is the source of (1) cotton cloth, (2) linen, (3) silk? Which kind of clothing is suited to warm climates? What is the difference between removing dirt and hiding it? What should be done after a room has been swept? Is it easier to keep the dirt out of a room that is simply furnished with a few things, or one containing many things? When is it best to take a warm bath? a cold bath? What else have you learned about bathing? Give an account of the village of X. Tell about the trouble, inconvenience, or ill-health that resulted to the inhabitants from mistakes in regard to clothing the neck, the feet, the waist; the length of skirts; the complexion; the hair. Compare the life of these people and of the rich people in the city.

CHAPTER XIII

THE CARE OF THE HEALTH

Is it more difficult to understand physiology or to practice the laws of health after you have learned them? It has been said that the Golden Rule, if followed, would cure all the evil and selfishness in the world; likewise a few simple laws of health, if followed, would prevent most of the sickness and suffering.

Perhaps you have known persons who believed in oxygen as the greatest need of the body, yet who kept their rooms tightly closed; who believed in deep breathing, yet bound the ribs with tight clothing.

Teachers have been known to give very interesting lessons on the benefit of fresh air, while at that very time the schoolroom was entirely without ventilation, its air being so foul that a newcomer would find the odor sickening.

Most people know that stimulants deceive; the Bible said many hundreds of years ago that "wine is a mocker, strong drink is raging," but stimulants are still one of the saddest of all curses of the human race. Some men drink in winter to keep out the cold. The same men drink in summer in order

to bear the heat. People drink in some countries because the climate is so moist, and in others because it is so dry. They give every reason for drinking but the true one, which is that they wish to rob themselves of to-morrow's strength before to-morrow comes.

Many persons care so little for health that they are far more likely to live properly if they think that by so doing they will improve their looks, than they are from the knowledge that right living will make them healthier and stronger and more useful in the world.

People know that work with the muscles is necessary to keep the blood fresh and pure, yet from indolence or for fear of soiling their clothes or for other trivial reasons, many neglect it entirely.

People know also that those who work little should eat little, yet they eat what they like and as much as they like. They know that tobacco is injurious, yet cannot give it up.

They injure their eyesight and nerves while striving after knowledge without wisdom, by bending over books. They exhaust themselves by worry, while they know that such a course injures them.

They lose their health and become invalids and then go from one doctor to another, and take one drug after another in vain. Thus they act as if they believe there is more health in powders and pills than in sunshine, useful labor, pure air, simple food, and a calm and contented mind; yet these natural remedies would probably restore them to health.

We should be careful that we do not deceive ourselves by saying that we believe the truth when we do not believe it.

CIGARETTES

Some boy may say: "I do not believe that tobacco is very harmful. My grandfather uses tobacco and it has not killed him. He is eighty years old and he still smokes cigars or a pipe every day." But this boy's grandfather did not begin smoking when a boy and thus stunt his growth, but waited until he was a man; moreover, he certainly did not smoke cigarettes. If, instead of smoking a pipe or a cigar once or twice a day, he had smoked dozens of cigarettes every day, he would have died long ago. As it is, he undoubtedly would have been a still stronger and sounder man if he had never used the poison.

Since no one can say any good of cigarettes, why is it that some boys learn to use them? There was a man that lived some years ago who taught that people are akin to monkeys and apes; this man might have said that boys learn to smoke just by imitating or aping other boys, but the author will try to give the true reason. The boys that have already learned to smoke cigarettes want company in their evil habit and hence they persuade other boys to smoke. Again, finding themselves slaves to a little cigarette only half as big as the little finger, they do not wish other boys to be strong and free while they are nervous and weak. Besides, the more boys that smoke, the more likely they are to get free

cigarettes if they are out of money for a time. For it is no slight thing for a cigarette smoker to be compelled to miss taking a smoke. Some of them can hardly wait from one recess to another, so strong is the craving.

In order to keep the smokers away from the other pupils, a principal once made a rule that boys could

From the Cosmopolitan.

FIG. 72. — The Elephant at Work.

The elephant is an intelligent animal. Once a man by way of a joke gave an elephant some tobacco. It was chewed a short time and rejected in disgust. Some months afterwards the man passed by again. The elephant remembered him, and, filling his trunk with dirty water from a pail near by, he gave the man a ducking.

smoke only in one corner of the school ground. The poor cigarette smokers had to stay there at recess nearly all the time.

There was a boy named Tom B. whom a teacher tried to prevent from smoking, for she noticed that he could not keep his mind on his books long enough to study and that he was lean and pale. Tom saw

that she was his true friend and he knew that cigarettes were ruining his happiness, so he promised her to give them up. It was a terrible struggle; his eyes glittered, he was fidgety and uneasy all the time. After a while he got over some of the bad effects of smoking and began to get stronger. But one day, soon after recess, he asked to be allowed to go out. The teacher noticed a very eager look on his face, and she stepped out into the hall and looked through the window; there was Tom, smoking again. The little cigarette had conquered. Tom had fallen, and he thought he did not have the strength to try again. Of course this was a mistake; if he had been willing to undergo the suffering, he could have conquered in the end. He soon stopped school, for he could make no progress in his books, and his life, like that of many cigarette smokers, was a failure.

GOOD TASTE AND HEALTHFULNESS IN DRESS

It is right that a girl should spend some time and thought upon her clothes and that they should be pretty and becoming; it is also right that she should take care that they do not deform her by their weight or tightness, or add to the work of the heart and lungs. The most healthful dress is not only the most becoming, but it preserves the good looks of the wearer. Unhealthful dress deforms the body and causes the loss of its natural grace. The human form is by nature one of the most graceful in the whole animal kingdom and has been called

the "human form divine"; we are told that man was made in the image of God. Anything that prevents free and easy movement or interferes with any of the organs, soon causes the body to lose health as well as grace.

God has made the *waist* the most movable part of the body. There the walls of the body swing gently in and out in natural, perfect breathing. The heart and liver and other vital organs partake of the benefits resulting from this freedom of motion. But because the waist is most free to move, it can be most easily deformed. Unfortunately, advantage is too often taken of its very perfection to bring about deformity.

The injury comes from stopping the motion of the waist in breathing. This injury is inflicted when the skirts are suspended from bands tied around the waist. The practice usually begins at the age when the girl is growing most rapidly; thus development at the waist is stopped. The organs there cease growing or grow down out of place.

If, by natural growth, a girl's waist would have reached the size of twenty-eight inches, do you think she can be strong and well when a woman if her waist measure is only twenty-four inches, the same size it was when she was but twelve years of age? Read again the allegory called "The Architect and his Two Friends" (p. 64).

If elastic bands are used to support the stockings, they should be carefully adjusted so as to be barely tight enough to do so.

Some people act as if they think God knows how little boys should grow to be men, but that it is left for the fashion makers to find out how little girls should grow into women. Instead of sup-

From the Cosmopolitan.

FIG. 73. — Under the Big Guns of the Flagship *Olympia*.

In this ship Admiral Dewey won the battle of Manila Bay. Notice that the admiral wears a white uniform. In a hot climate like that of the Philippines, white clothing is the most healthful because it reflects the rays of the sun.

porting the clothes from the strong, bony, muscular shoulders, the most delicate part of the body is selected for the purpose. If they try to do better, such people get deceptive "health waists," which

they fasten so tight around the waist that the shoulder straps are loose and support no weight at all. If the mother says to her daughter, "My dear, I think your dress is too tight," the girl may reply, "No, it cannot be, for see! when I send out my breath, I can get my hand beneath my belt." Of course she can get her hand beneath her belt. If she should draw the belt to the smallest size of the waist when the breath is out, the breath would scarcely come back and she would be in danger of smothering. If the belt or skirt is tight enough to be held in place by the pressure, it is interfering with her breathing and with free and perfect growth. If she takes exercise or plays active games in this condition, she may be injured instead of being benefited.

Every boy and girl should have, as the standard of growth, the fullest development that the "human form divine" is capable of reaching with perfect freedom and healthful living; and both boys and girls should so live as to reach their ideals.

THE LIVING TEMPLE

Not in the world of light alone,
Where God has built his blazing throne,
Nor yet alone on earth below,
With belted seas that come and go,
And endless isles of sunlit green,
Is all thy Maker's glory seen;
Look in upon thy wondrous frame,
Eternal wisdom still the same!

The smooth, soft air, with pulselike waves,
Flows murmuring through its hidden caves,
Whose streams of brightening purple rush,
Fired with a new and livelier blush,
While all their burden of decay
The ebbing current steals away;
And red with Nature's flame they start
From the warm fountains of the heart.

No rest that throbbing slave may ask,
Forever quivering o'er his task,
While far and wide a crimson jet
Leaps forth to fill the woven net,
Which in unnumbered crossing tides
The flood of burning life divides;
Then kindling each decaying part,
Creeps back to find the throbbing heart.

But, warmed with that unchanging flame,
Behold the outward moving frame;
Its living marbles jointed strong
With glistening band and silvery thong,
And linked to reason's guiding reins
By myriad rings in trembling chains,
Each graven with the threaded zone
Which claims it as the Master's own.

See how yon beam of seeming white
Is braided out of seven-hued light;
Yet in those lucid globes no ray
By any chance shall break astray.

Hark how the rolling surge of sound,
70 Arches and spirals circling round,
Wakes the hushed spirit through thine ear
With music it is heaven to hear.

17 Mark then the cloven sphere that holds
All thought in its mysterious folds;
That feels sensation's faintest thrill,
And flashes forth the sovereign will;
Think on the stormy world that dwells
Locked in its dim and clustering cells!
The lightning gleams of power it sheds
18 Along its hollow, glassy threads!

O Father! grant thy love divine
To make these mystic temples thine!
When wasting age and weary strife
Have sapped the leaning walls of life,
When darkness gathers over all,
And the last tottering pillars fall,
Take the poor dust thy mercy warms,
And mold it into heavenly forms.

—Oliver Wendell Holmes.

From "The Autocrat of the Breakfast Table," by permission of Houghton, Mifflin & Company. The numbers refer to pictures in this book.

CHAPTER XIV

PUBLIC HEALTH

FLIES, FILTH, AND FEVER

Flies and our Food. — Flies breed in filth and carry disease to food and drink. A fly never wipes his feet when he enters the kitchen and he never washes himself with water. Baby's bottle is a favorite playground for flies. One fly can carry thousands of typhoid germs from the closet vault, crawl over food and hands and face, and make people ill. Disease germs breed more readily in milk than anywhere else: if a fly with a germ on it falls into milk, what happens at once? What may happen later? Flies kill more people than mad dogs do. Do we need official fly catchers as well as official dog catchers?

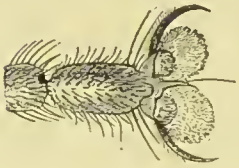
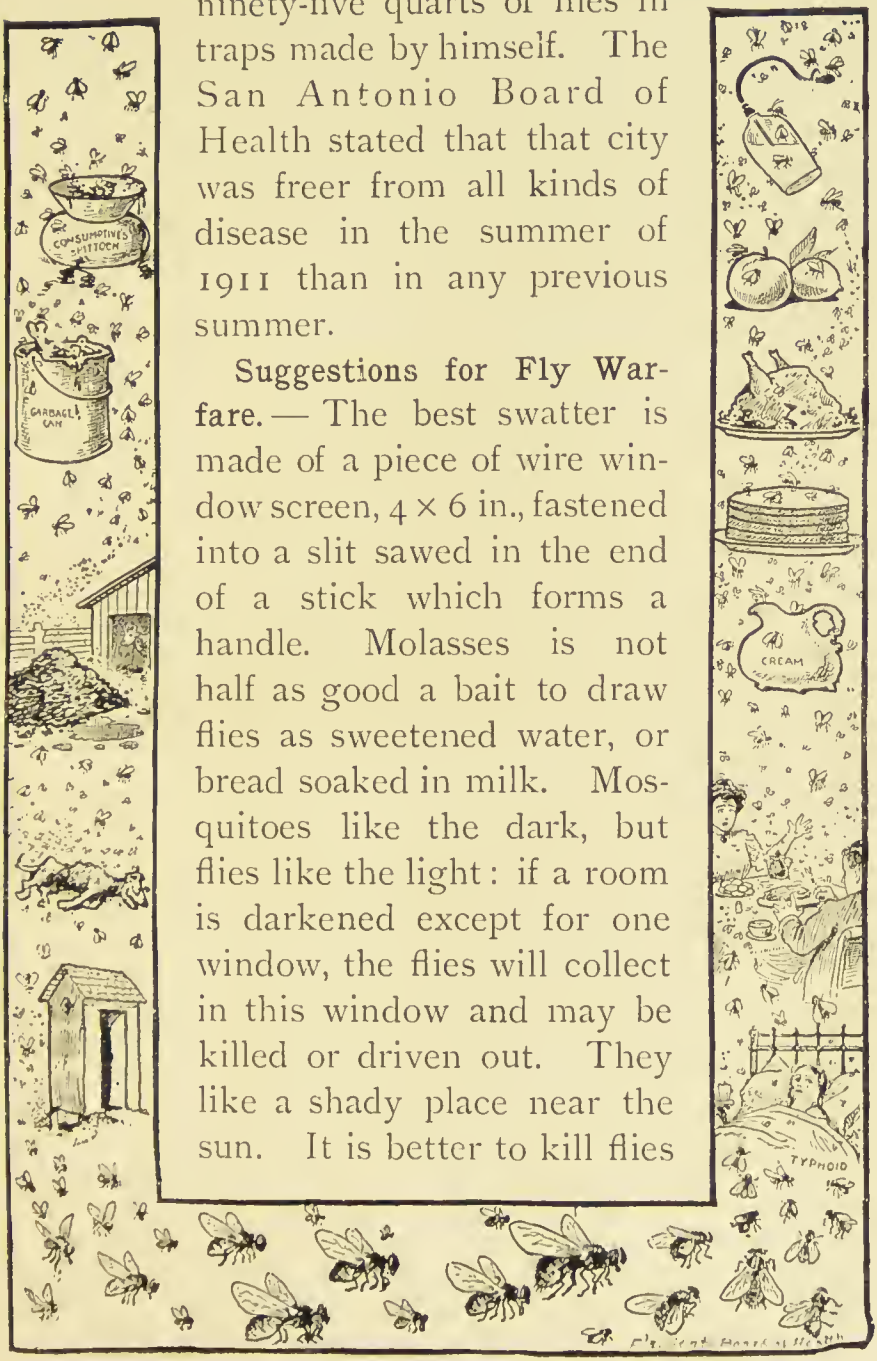


FIG. 74. — Foot of fly.

War on Flies. — The first general war on flies began in San Antonio, Texas, June 14, 1911, and lasted until July 3. The total slaughter was 1,250,000 flies. Piled up, they made a pyramid five feet across and three feet high. The most successful fighter was a boy eleven years old, who brought into the office of the San Antonio *Daily Express* a sugar bag containing half a million flies, and won a prize of $10. Worcester, Mass., and Washington, D.C., had contests soon afterward.

In Worcester one boy twelve years old caught ninety-five quarts of flies in traps made by himself. The San Antonio Board of Health stated that that city was freer from all kinds of disease in the summer of 1911 than in any previous summer.



Suggestions for Fly Warfare. — The best swatter is made of a piece of wire window screen, 4 × 6 in., fastened into a slit sawed in the end of a stick which forms a handle. Molasses is not half as good a bait to draw flies as sweetened water, or bread soaked in milk. Mosquitoes like the dark, but flies like the light: if a room is darkened except for one window, the flies will collect in this window and may be killed or driven out. They like a shady place near the sun. It is better to kill flies

in June than in August; one fly killed in June may mean hundreds less in August. Are you helping or hindering the health of the people? Do you breed or kill more flies in your home?

Prevention of Flies. — Flies are such a nuisance that the work of preventing or killing them would be repaid in comfort alone, even if they did not

FIG. 75. — A fly's descendents in one season, if all survived. Notice the rate of increase is greatest in summer.

bring disease. It is easier to stop the breeding of flies than it is to kill them after they have come. Nineteen out of twenty flies come from horse manure. They also breed in toilet closets, garbage cans and heaps, piggeries, street sweepings, wastes of slaughter houses, in ash dumps, in old straw, and even between the folds of old paper; in fact, wherever there is suitable food and moisture for the maggots.

A fly lays about 120 eggs; the eggs hatch in eight hours; maggots grow for five days; they are

quiet for five days while changing into flies. It is ten days from egg to fly; hence, garbage and manure should be removed oftener than once in ten days (once a week). If flies begin to hatch in a manure pile, they may be killed by spraying with kerosene, using a garden sprinkler.

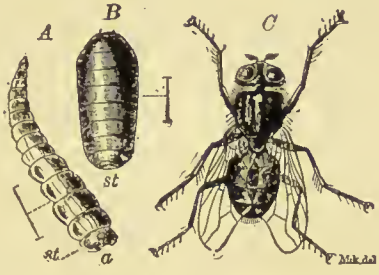


FIG. 76. — The stages after a fly's egg hatches.

Further Suggestions. — All wastes from the sick room may be disinfected and disease germs may be killed by the use of bluestone (two pounds to a barrel of water). From putrid matter, flies may carry disease to the baby. If there is any catching illness in your neighborhood, beware of flies. How would you like to have a fly crawl in the filth of a spittoon which a consumptive has used, and then crawl on your hand or face or clothes? Kill it instead. "Fly specks" are dangerous. They may contain typhoid germs and other germs that have passed through the body of the fly. Careful housekeepers have scales and measures in the kitchen to see that they are not cheated; they know that if a grocer or butcher touches the scales while weighing, he may be trying to cheat; but it is much more important for the housewife to buy her goods from a store that is carefully screened from flies.

Breeding places (stables, manure piles, closets) should be screened. Windows should either be kept down, or all the way up; for if the screen frame

is not even with the sash, flies and mosquitoes come between the screen and the glass.

TUBERCULOSIS

Every three minutes some one dies in the United States from tu-ber-cu-lo'sis. The disease is caused by a tiny vegetable germ which grows in the body and destroys some part of it. The germs may grow

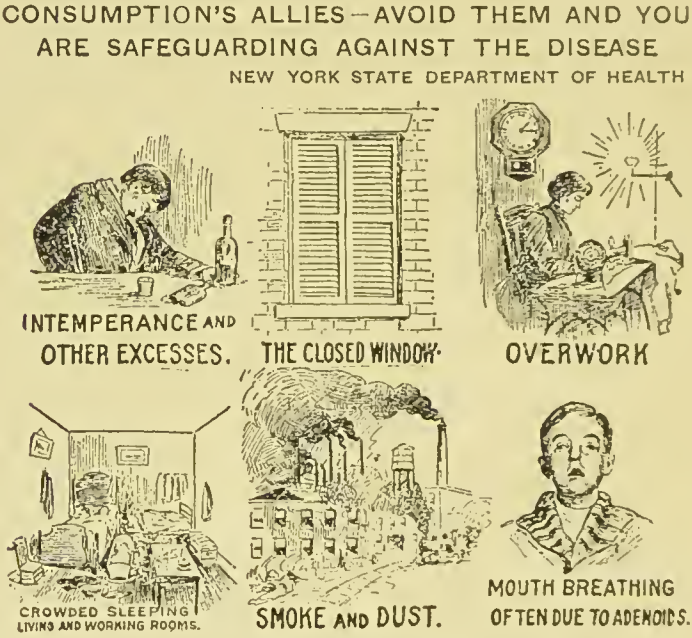


FIG. 77. — This and Figs. 78, 79 and 80, are blackboard sketches.

in almost any part of the body, but they grow most readily in the lungs and cause the kind of tuberculosis called "consumption." This is the kind most often met with. The germ of consumption is a plant and not a bug or any kind of animal life.

Early Symptoms. — 1. Undue weariness or weakness. 2. Persistent coughing and spitting. 3. Fre-

quent colds, or a cold that hangs on. 4. Loss of appetite, of flesh, of color. 5. Pains in the chest. 6. Fever in the afternoon; and, later, night sweats.

Where it thrives. — Tuberculosis is a house disease; it thrives in dusty houses. Houses with curtains and carpets are always dusty. It thrives in dirt and filth where people are careless and unclean. Sunlight and pure air help to prevent it.

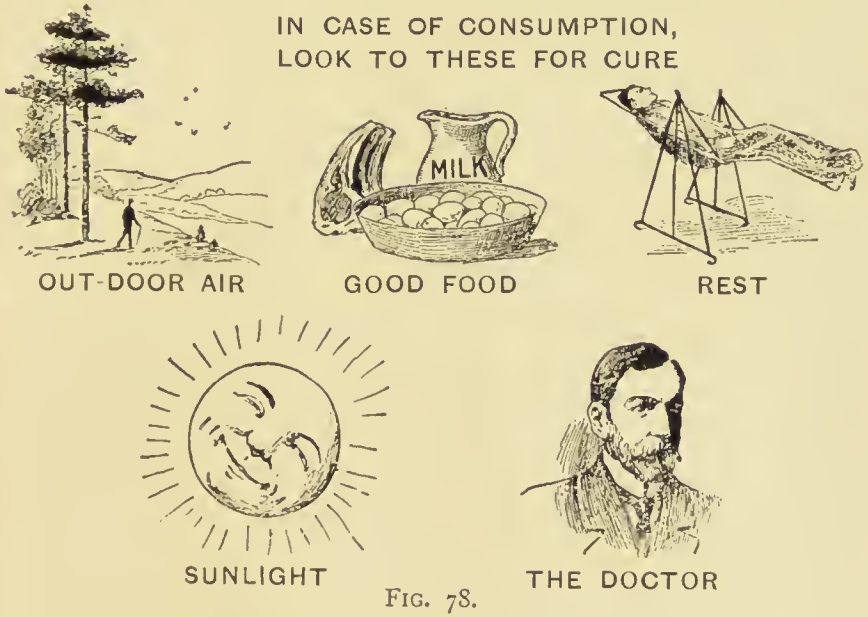


FIG. 78.

The germs are most likely to grow in a body weakened from these causes: Intemperance and all excesses; impure air and dark rooms; impure or indigestible foods; overcrowding, overwork, idleness. Measles, grippe, typhoid fever, pneumonia, whooping cough, or hookworm may so weaken the body that it cannot resist the germs of tuberculosis.

The Cure. — Tuberculosis may be cured by regular habits, fresh air, sunshine, food, rest, and work.

Patent medicines are harmful; they do not cure. To be cured and stay cured, one must persevere in careful living long after all signs of the disease have disappeared. Those who keep up courage and cheerfulness get well quicker; brave people

FIG. 79.

are not so liable to get the disease They remember that the skin and mucous membrane protect from germs; the gastric juice and other juices kill germs; and they remember the protective power (p. 72) of the valiant little white corpuscles which are everywhere in the body, and are always ready to defend it. Even the liquid part of the blood destroys germs.

Cost of Tuberculosis. — This disease does not attack old people and babies as often as it does

people in the active, working period of life. Many children are made orphans by it. Many families are brought to poverty by the long, tedious disease. But greater than the great loss to the nation is its cost in needless human suffering.

How the Disease Spreads. — No child is born with this disease. The germs get into the body after birth. They are carried from the consumptive's spittle to well persons whose bodies are not strong

HOW THE GERMS OF CONSUMPTION ARE CARRIED FROM THE SICK TO THE WELL

FIG. 80.

enough to kill the germs. A consumptive worker in a factory may infect other workers. Flies help to spread it by carrying the germs from the consumptive's spit to food in the grocery store, kitchen, or dining room. People, especially children, may take it by drinking the milk of tuberculous cows.

Questions. — When is a consumptive not dangerous to other people? (See the pictures.) What is tuberculosis of the lungs called? What can be done at home to protect the family against consumption? (See pictures.) What are consump-

tion's allies? (See pictures.) Do you know that every one's interests are concerned in one way or another in the fight against it?

FIG. 81. — Sitting so as to invite consumption.

A Sound Body protects Itself. — Do you know that you have probably breathed these germs into your lungs without harm, hundreds of times already? Do you know that a weak body is as necessary as a germ before the disease can begin? One's body may be weak habitually because of wrong living; or it may be weak for the time because of extra work, worry that has preyed upon the mind, loss of sleep, exposure, indigestion from overeating, indoor life in dusty houses without exercise.

A Few Don'ts. — DON'T live, study, or sleep, in unventilated or dusty rooms; fresh air and sunlight kill the germs of this disease and of other diseases. Have as much air and light in your room as possible. DON'T live in dusty

FIG. 82. — Sitting so as to avoid consumption.

air. Keep your rooms clean by using damp cloths and mops. DON'T use a dry broom or a feather duster. Keep at least one window open in your bedroom at night, and air the room several times a day. DON'T eat with soiled hands; wash them first. DON'T put your hands or pencils in your mouth. DON'T put in your mouth candy, chewing gum, cups, or spoons that others have used. DON'T keep soiled handkerchiefs in your pockets. DON'T neglect to bathe regularly.

A person who has tuberculosis should not waste money on patent medicines or advertised consumption cures, but should follow a doctor's advice. He should not drink whisky or other forms of liquor. He must not sleep in the same bed with any one else, and if possible, not in the same room. He should keep out in the fresh air and sunlight as much as possible. He must begin to live properly before it is too late. In fact, even a bad cold should be a warning to live in a better way. He must work out of doors; he must wear loose clothes; he must eat plenty of good food (eggs, milk, bread and butter, fruit, olive oil, etc.); he must eat in the open air so that he will have a good appetite. He must keep the windows open winter and summer, day and night; if he is properly wrapped, he will not catch cold. Fever at any part of the day is a sign that work or exercise has been too tiring.

He should follow these rules, which even a healthy person should follow: Do not swallow spittle. Do not spit on the sidewalks, playgrounds, floors of

home or school. It spreads disease; it is indecent and against the law. Spit in the gutters, or in a spittoon half filled with water, or in paper to be burned before it dries. Hold a handkerchief or a hand over the mouth or nose when coughing or sneezing.

The fresh air treatment may be used wherever there are windows in walls, a porch to the house, or space in the yard or on the roof in which to pitch a tent.

FRESH-AIR SCHOOLS

Fresh-air schools for delicate children were first opened in Germany. The children were taught in parks, with shelter near by for use when it rained. In this country, in Rhode Island, men who were fighting tuberculosis, recently examined some schoolrooms. They found one schoolhouse with the windows nailed down; in other schools the floors were washed only once a year, desks were rarely cleaned, and floors were swept without the use of damp sawdust or anything to lay the dust. Many children had lung disease. So open-air schools were started.

Three things were soon noticed about the children in those schools. (1) The children almost stopped having colds, swollen tonsils, and sore throats. If one child took a cold, the others did not take it also. (2) Instead of their health getting worse in school term, as it had done in the usual stale-air schools, their health got better and they grew faster than children in the other schools; their blood became a deeper red and their cheeks were rosier. (3) They

made faster progress in their studies than they had made in the closed-in schools. The pupils did not gape or yawn or become tired. It has been proved that open-air and open-window schools restore weak children to health; then is it not clear that they will give children who are well great aid in keeping well?

The Schools Described. — The windows are wide open on the south and east sides away from the cold

From Open Air Crusaders. Courtesy Elizabeth McCormick Memorial Fund.

An open-air school in the severe climate of Chicago. How much easier in a warmer climate!

winds. If there are not enough windows, both sashes are taken out of every window on these sides. The room may be heated on very cold days. In winter the children should dress very warmly or should keep on their wraps. In some open-air schools in the coldest weather thick sweaters, leggins, and felt shoes are worn. In the Washington City open-air schools there is a blanket for each child to use if desired. The blankets are usually

wrapped around the feet and legs. Between the lessons there are games, gymnastics, play-acting, etc., so that exercise may warm the blood. The school work is done with less strain, and the school is in session fewer hours. Dullness, restlessness, forgetfulness, and weak bodies result from closed schoolrooms; quicker learning, better memory, more work done, health, and happiness, are found in schools having pure air.

Sleeping in a Graveyard. — In Deptford, England, about twenty schoolboys sleep in the graveyard of the church. They have sheltered beds, and for very cold nights they have blanket sacks in which to wrap themselves. Their improvement in health in a short time has been amazing. Besides their lessons they study gardening by making a garden.

Playgrounds should have at least thirty square feet of ground for each pupil. A school should never be on a main street or road, because of the noise, dust, and the danger that children may be run over. It should be surrounded by trees.

Fresh Air and Business. — An insurance company had 80 clerks in one office. One in 10 was always absent from illness. Later, with fresh air in the office, less than one per cent was absent from illness. At a straw hat factory in Baltimore the average sick rate was 28 in 100; after the introduction of proper ventilation, the sick rate was 7 in 100.

Fresh-air Schools in Warm Climates. — It is a terrible thing to shut up 40 tender children in a room

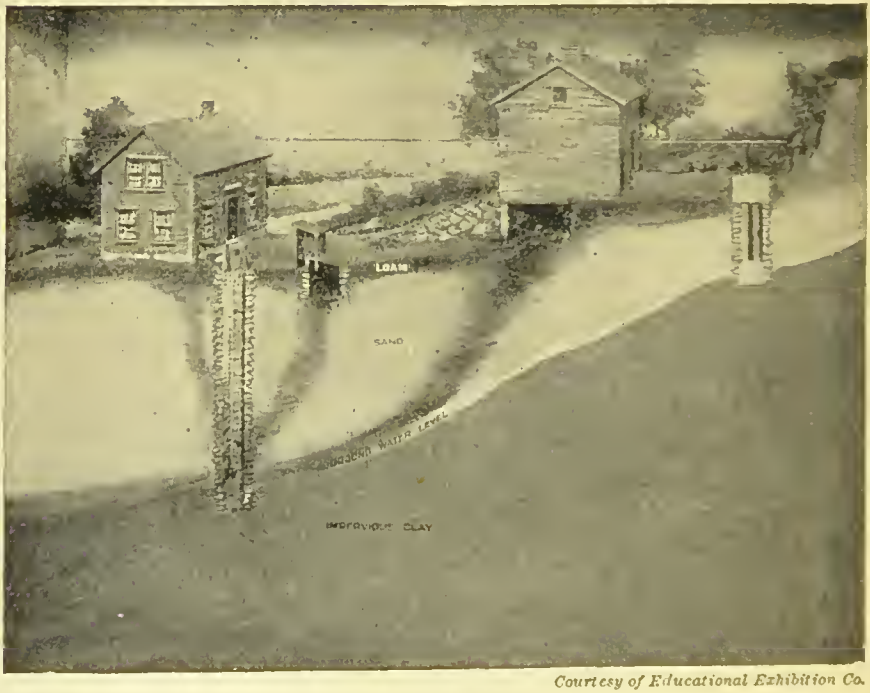
where they must breathe each other's breath for hours. Some of them are always sickly, and about half of them usually have more or less discharge from the nose.

In the Gulf States, both sashes may be taken out of every window, except during the three winter months; the windows may be closed by wooden shutters at night. Or the south wall may be replaced by heavy slats that keep out the glare and the rain, but do not obstruct the air. The coolness is as beneficial as pure air; for when the temperature rises from 70 to 80 degrees, the working power of the pupils is lowered 30 per cent. In warm climates, close confinement has far worse effects than in cold climates, and open-air or out-door schools are much easier to arrange and conduct; schools in summer should be held under the trees if there is good shade. Have you fine trees about your school? If not, are you planting trees every year?

FIG. 84. — PARASITES OF MALARIAL FEVER in the red blood cells. At left those that cause "third day chills"; next, those that cause "second day chills"; last, those that cause malignant fever. They all destroy the blood cells, the last causes the cells to enlarge before they break up.
The malarial mosquito has spotted wings and rests with its "tail" pointing upwards.

FIG. 85. — One barrel or tub of water can breed enough mosquitoes to torment a whole neighborhood and spread much malaria.

FIG. 86. — These boys are practical hygienists. They have found there are myriads of mosquitoes in these boats. They will turn the boats over. Is there malaria in your community? What are the people doing to stop it? What are you doing?



Courtesy of Educational Exhibition Co.

FIG. 87. — A SAFE AND A DANGEROUS WELL. Where should the dwelling have been placed, and where the barn? Impure water weakens the body so that malarial germs make it ill. If well water has wigglers, the well should be screened at night to keep out mosquitoes.

APPENDIX

LESSONS FOR REVIEW

TO THE TEACHER. — It is important that the pupils recite all of these lessons before completing this book. Portions of them may also be used for matches and contests while studying the text. These contests may be varied as follows: (1) two pupils may choose sides; (2) the boys and girls may be on opposite sides; (3) the teacher may assign the pupils to the sides from certain rows; (4) the contest may be individual. The pupils may be seated when they answer wrong; or the pupils may be seated when they answer correctly, those missing to stand on the floor until they answer a question correctly. The pupils may be allowed to stand at their seats, or in rows along the wall, as in the old-time spelling matches. These contests should be held once a month, or oftener; they will be found to add greatly to the interest of the work. Perhaps the "Quaker method" of review will be found most instructive. In this the teacher announces a certain chapter or subject, and says nothing more except to recognize those that volunteer to recite. When the pupils exhaust their knowledge, he announces another subject.

Review Lessons on Hygiene will be found on pages 53, 66, 88, 97, 110, 129, and 157.

Lesson 1. *Chapter I.* — Does the backbone consist of one or many bones? Why is it elastic? Why is the skull round in shape? What is the advantage of having the eyes high in the head, the mouth low, and the nose above the mouth? Why is it well that the brow, the nose, and the cheek bones stand out around the eyes? What are the two rooms or divisions in the trunk? How are they separated? What does the upper division contain? What organs are in the lower division of the trunk? What two bones form a kind of basin?

What is the shape of the shoulder blade? What is the use of the collar bone? How long does it take for a broken bone to heal? What is a joint? How many bones are in the upper arm? How many bones in the lower arm? What is the shape of the wrist bones? How many bones are in the palm? Why does the skeleton hand

appear to have very long fingers? Why is the thumb more useful than a finger?

Lesson 2. — Do the bones of the leg correspond to the bones of the arm? Which is the largest bone in the body? What name has it in the full-page picture of the skeleton (p. 182)? Why is it so large and strong? To which bone in the leg is there no corresponding bone in the arm? What is the use of this bone? Are the bones of the leg and arm equal in number? What are the names of the two bones of the lower leg? Which one is smaller? Can you give their scientific names (p. 182)? The ball of the foot corresponds to what part of the hand? How are the bones of the foot, as a whole, arranged? What is the use of this arrangement? Why must the bones of the hand be different from those of the foot? Compare the hand of a man with that of a monkey.

Name two places in the body where the joints are not movable. How many bones are found in the entire body? How many bones are in the skull?

Lesson 3. — Name the five kinds of movable joints. What is a hinge joint? Name several hinge joints. What kind of motion does a ball and socket joint allow? What are the parts of a ball and socket joint? Give an example of this kind of joint. Why must the hip joint be deeper than the shoulder joint? What is a pivot joint? Give an example. Where are gliding joints found? Why are you not so tall at night as in the morning? What is cartilage, and where is it found? What is its use? What kind of joint has no cartilage in it? One cartilage? Two cartilages? What are ligaments, and what is their use? What makes the joints work smoothly?

In what ways is the body more wonderful and convenient than any house? What goes to the bone through its tough coat or covering? When a bone is healing, what is formed before new bone is formed? What parts of the

thigh bone are spongy? (See Fig. 14.) What part of it is dense? What part is filled with marrow? Of what is bone composed? How may each kind of matter be taken out of a bone? How do the bones of children differ from the bones of older people? Name seven animals with backbones. (Fig. 15.)

Lesson 4. *Chapter II.*—What does physiology treat of? What do we call a part of the body that has a special work to do? What is a function? What is meant by the science of hygiene?

When you move a hand, where in the body does the action start? Describe the appearance of the outside of the brain. What is the function of the brain? Is the connection of mind and body understood? How does the brain control the foot? What is the spinal cord? How large is it? Are the nerves larger in the hip or the shoulder? (Fig. 16.) What are the two kinds of nerves? What is the function of each kind? Explain what makes the "foot go to sleep." How do you test where the sensory nerves are most numerous? Where do you find the greatest number to be? Explain how it is that there may seem to be an itching in a hand after the hand is cut off. When a finger itches, where is the feeling? If there is itching in the stump that remains after a limb has been cut off, how can the itching be stopped? Why is the "funny bone" so called?

What are voluntary acts? What are reflex acts? When may reflex acts be seen in a chicken? How many nerve cells are necessary for a reflex act? (Fig. 18.) Name six acts that are reflex.

Lesson 5. *Chapter III.*—How does the chest wall move (1) when the breath comes in? (2) when it goes out? Answer the same question in regard to the walls of the waist and abdomen. How is the chest expansion found? What is your chest measure? Your chest expansion?

Your waist expansion? Who can run or work longer, a boy with a large chest, or with large muscles? What does respiration mean? What is (1) inspiration, (2) expiration? What bones are used in breathing? Describe the diaphragm. Where is it situated? How does it move during inspiration? During expiration? Where do the muscles contract when you cough?

Give two reasons why it is better to breathe through the nose than through the mouth. What is the larynx made of? Where are the vocal cords? How is the voice produced? Why is the windpipe made of cartilage? What is contained in pure air that is lacking in the impure air that comes out of the lungs?

Lesson 6.—Where are the lungs? How far below the throat does the windpipe begin to branch? Describe the branching. What are found in the ends of the smallest tubes? What part of the air passes through the thin walls into the tiny blood vessels surrounding the cells? What passes from the blood vessels into the air cells of the lungs? We breathe to supply oxygen to the body; but why is oxygen necessary for the body? What process is the basis of life? What happened to the candle flame when your teacher covered the candle with a glass jar? Why? How can you prove that the air in the jar when the flame goes out is different from the air of the room? What must be continually supplied in order that a candle may burn? If you pour lime water into the bottle after the candle has gone out, and shake it, what will happen? This shows that what gas is in the bottle? How was this gas formed? How is this gas formed in the body?

Lesson 7.—Describe the experiment which you tried, to show that the breath contains so much carbon dioxid that it will put out a candle. How does the experience of well diggers show that air that will not support the combustion of a candle will not support the life of a man? Explain

how the food in a living body corresponds to the tallow in the burning candle. How can it be proved that there is carbon (1) in sugar, (2) in corn? How large a part of the air is oxygen? How can you prove that water is given off by a candle flame? How is this water formed? How can you prove that water is given off on the breath? How is it formed in the body? Fox fire is caused by the oxidation of what substance? How is iron rust formed? How does a locomotive resemble a man? What is the most important difference between a man and a locomotive? Tell the story of the "Ship in a Storm."

Lesson 8. *Chapter V.*—What is the temperature of man's body? Is it the same in winter and in summer? Where does the oxidation take place in the body? If you cut your finger, what presses the blood out? Of what is the heart made? What is its shape? Its size? In what places may the pulse be felt? What occurs before each beat of the pulse? What are (1) arteries, (2) veins, (3) capillaries? What does blood take to the organs? What does it bring from them? What are the three parts of the blood as seen under the microscope? What do the red corpuscles carry? What is the duty of the white corpuscles? Blood passes through the heart in how many directions? What is the name (1) of the upper chambers in the heart, (2) of the lower chambers? Trace the blood through one complete circuit. Tell the story of the travels of a blood cell.

Lesson 9. *Chapter VII.*—What is the alimentary canal? How long is it? What purposes are served by food? What is the name of the process by which food is made soluble? Name the kinds of food that serve only to give heat to the body (or to form fat). What class of foods repairs and builds up tissues? Give examples of food that are (1) chiefly tissue builders, (2) fat and heat givers, (3) that belong to both classes.

What is the relation between food and climate? State

what you have learned about these foods: green vegetables, fruits, water, salt, meat, fats, nuts, cottonseed oil, olive oil, wheat flour, peas, and beans. Where do our bodies get lime and phosphorus? Why is it not necessary for the oily yolk of the egg to be as large as the white of the egg?

Lesson 10. *Chapter VIII.* — Why must food be chewed? What is the first set of teeth called? The second set? How many cutting teeth (incisors) in the whole mouth? (Fig. 44.) How many dog (canine) teeth? How many chewing (bicuspid) teeth? How many grinding (molar) teeth? If food that turns sour remains on the teeth, what will result? What is (1) pulp, (2) dentine, (3) enamel? How may the teeth be broken? What is the effect upon the teeth of using them?

If you chew starchy food for a long time, how does the taste of the food change? What caused this change? What states of mind prevent the flow of saliva? Where is saliva formed? Discuss chewing gum and chewing tobacco.

Lesson 11. — What is the gullet? How is food prevented from entering the windpipe? Describe the stomach. What fluid is formed by the walls of the stomach? What food does it act upon? What is the pylorus? When will it allow food to pass? Describe the digestion in the small intestine, stating what fluids act upon the food, where these fluids are formed, and naming the foods they act upon. State the functions of the liver. Into what vessels is the blood absorbed? How is it carried by the tissues? What part of the blood leaves the capillaries and goes into the tissues? What is it then called? How does the lymph get back into the blood? Did you ever see the watery lymph in a blister? What is the function of the kind of lymphatics called lacteals?

Lesson 12. *Chapter IX.* — What causes food containing sugar to spoil? What is fermentation? How may sweet

drinks be kept sweet for an indefinite time? What gas and what liquid are produced by fermentation? How is vinegar produced? How is vinegar adulterated? How is beer made from barley? Why do men distill fermented liquors? Describe the process of distillation. Name several distilled drinks and the fermented drinks from which they are made. How is champagne usually adulterated? Men of what disposition are most apt to seek stimulants? What should a person do when he feels tired or downhearted?

Lesson 13. *Chapter X.* — To what are muscles usually attached? By what means are they attached? How is a muscle aroused to work? Why does a man fall if he receives a blow upon the head? What are the two kinds of muscles? Give an example of each. What is the difference between a tendon and a ligament? Describe the structure of a muscle. Of what is the substance of muscle built up? What chemical change takes place in the muscle as it contracts? What is the effect of muscular exercise upon (1) the muscle, (2) the circulation, (3) the lungs, (4) the skin, (5) the appetite? When should vigorous exercise not be taken? How does change of work give rest? Can you repeat the imaginary argument between Benjamin Franklin and the Gout?

Lesson 14. *Chapter XI.* — Name the two layers of the skin. What is the structure of (1) the outer layer, (2) the inner layer? What is found beneath the dermis? What is the mucous membrane? Why is food that has been swallowed not really in the body? What is a blister? How do you know that the epidermis has no nerves or blood vessels? Tell about shedding the epidermis.

From what does the hair grow? Tell what you know of (1) the oil glands, (2) the sweat glands, (3) the nails. Give instances of impurities entering the body through the skin.

Lesson 15. *Chapter XII.* — What are the five special senses? Why were seven once counted? What knowledge is given us by the general sense? From what does pain result?

Where, in the skin, is the sense of touch located? What is signified by the ridges in the palm? Of what two senses does the muscular sense consist?

What are the four chief kinds of taste? How are flavors detected? How can this be proved? In what state must a substance be in order to affect the nerves of taste? Show how a natural instinct must be intentionally deceived in order to drink coffee. What troubles are sometimes caused by drinking it? Tell about coffee drinking in Brazil.

Lesson 16. — How do the branches of the nerve of smell reach the nose? In what part of the nose is the sense of smell most acute? Of what use is the sense of smell?

How is the eyeball placed in the skull? Tell what you know of (1) the optic nerve, (2) the cornea, (3) the iris, (4) the pupil and its varying size, (5) the crystalline lens. What fills the main chambers of the ball? What is the retina? State the causes of near-sightedness and far-sightedness, and illustrate by figures. State ten facts concerning the care of the eyes.

What are the three divisions of the ear? Describe each. What are the parts set in motion by a sound wave before it reaches the nerve of hearing? Repeat the hints concerning the care of the ears.

WORDS PRONOUNCED AND DEFINED

Abdo'men. The part of the body below the chest which holds the stomach, liver, kidneys, etc.
Aliment'ary. Nourishing.
Al'legory. A story where things stand for persons.
Am'putate. To cut off.
Artery. A tube taking blood *away from* the heart.
Auricle. A chamber of the heart that receives blood.

Bile. Gall, the secretion of the liver.
Bronchial tubes. The smaller branches of the windpipe.
Bronchi'tis. A cold in the chest.

Cap'illary. A tiny blood tube connecting vein with artery.
Car'bon diox'id. The gas formed by oxidation.
Car'tilage. Gristle.
Cell. Tiny, jelly-like units that form tissue; they can be seen only through a microscope.
Chest expansion. The difference between the measurements around the chest when contracted and expanded.
Chyme (kīme). See page 103.
Coag'ulate. Clotting of blood, so that it becomes half-solid.
Cor'nea. See page 152.

Dermis. The deeper layer of the skin.
Di'aphragm (-frăm). See page 43.
Diges'tion. The process of changing food to a liquid ready to be absorbed into the circulation.
Dilate'. To widen.

Epidermis. The outer layer of the skin.
Evapora'tion. The change of a liquid into a gas or vapor.
Exhale. To breathe out.
Expiration. The act of sending air out of the lungs.

Fermentation. The action of yeast on sugar by which it is changed to alcohol and carbon dioxid gas.
Function. See page 28.

Gas'tric. Belonging to the stomach.
Gelatine. A glue-like substance in animal tissues.
Gland. A tubular organ which forms and deposits, or secretes, liquid substances.

Hy'giene. Science of health.

Inflammation. Swelling, with redness, and soreness, and sometimes pus.
Inhale. To draw in the breath.
Inspiration. Act of inhaling.

Kidneys. Two large glands which purify the blood by secreting urea.

Lac'teal. See page 106.
Ligaments. Tough fibrous bands or cords which hold bones together at the joints.
Lymph. Watery portion of the blood which has left the capillaries to reach and nourish the cells.
Lymphat'ics. Tubes which return the lymph to the veins.

Mi'croscope. An instrument for making tiny things appear large.
Mucous membrane. A thin skin-like lining to all cavities of the body reached by air.
Mucus. The slimy secretion formed by mucous membrane.

Narcotic. Stupefying, deadening.

Optic. Belonging to the eye.
Organ. See page 28.
Oxidation. The union of oxygen with another substance.
Oxygen. An active gas in the air which unites with other substances, giving rise to heat.

Pancreas. See page 104.
Physiology. The science of the activities, or functions, of living things.
Pneumonia (nū-). Inflammation of the lungs.
Pro'teid. Tissue-forming food.
Pulse. The swelling which passes along an artery after each heart beat.
Pylo'rus. The narrow opening of stomach into intestines.

Reflex. Turned back.

Sali'va. The secretion from the glands near the mouth which begins digestion.
Science. Orderly knowledge.
Secretions. Liquids formed by glands.
Sensory. Belonging to feeling.
Spine. The backbone.
Sprain. A torn or injured ligament.

Tendon. White fibrous cords (leaders) which fasten muscles to bones.
Tissues. Structures which make up organs.

Veins. Blood tubes leading *to* the heart.
Ven'tricles. Chambers which expel blood from the heart.
Vol'untary. Belonging to the will.

FIG. 88. — His chest is flat, his back is rounded; it should be just the other way

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A good posture.

Will he have a crooked back?

A good posture.

From Herms' Malaria, Cause and Control.

A typical breeding place of the dapple-winged, or malarial, mosquito: a permanent pool, shallow, clear, and grassy. It should be drained; in the meanwhile, the inspector is ready to use his knapsack sprayer.

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